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JOHN F. KENNEDY SPACE CENTER

DESCRIPTION AND GENERAL OPERATING GUIDELINE FOR KSC LIGHTNING WARNING SYSTEM

MEASUREMENT SYSTEMS DIVISION

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SECTION I

INTRODUCTION

1.1 PURPOSE

This manual explains the Lightning Warning System (LWS) of Kennedy Space Center (KSC) and outlines procedures for operation of units of the system. Operations include the setup and checkout of sensors at ten remote locations and readout units at central monitoring points.

Three types of lightning or potential lightning activity measurements are sensed. These include potential gradient (PG), corona current (CC), and sferics, or lightning discharges. Figure 1-1 shows the locations of the measurement sites at KSC and figure 1-2 shows the LWS measurements flow

The PG measurements use sensors (probes) to help predict hazardous conditions by sensing the potential energy (kilovolts/meter or Volts/meter/second) of passing clouds with respect to earth. The CC measurements use whip antennas to measure current flow in the surrounding air resulting from the presence of a charged cloud. Sferics measurements use loop and sense antennas as direction-finding elements to obtain a general fix on lightning discharges (strikes). Sferics information from two stations permits operators to map the paths of thunderstorms. The KSC sferics system is designed for local (50-miles-or-less) tracking capability.

Monitoring points for readout purposes are the Blockhouse of LC-37, the LCC, and the Meteorological Prediction Center (MPC), located in Room 4723 of the Manned Spacecraft Operations Building (MSOB). The PG, CC, and sferics information to central monitors is as follows.

Potential Gradient and Corona Current-

Site 1	to	LC-37 Blockhouse and MPC
Sites 2 and 3	to	MPC
Sites 4 through 8	to	LCC and MPC

Sferics Stations-

Station 1	to	MPC
Station 2	to	MPC

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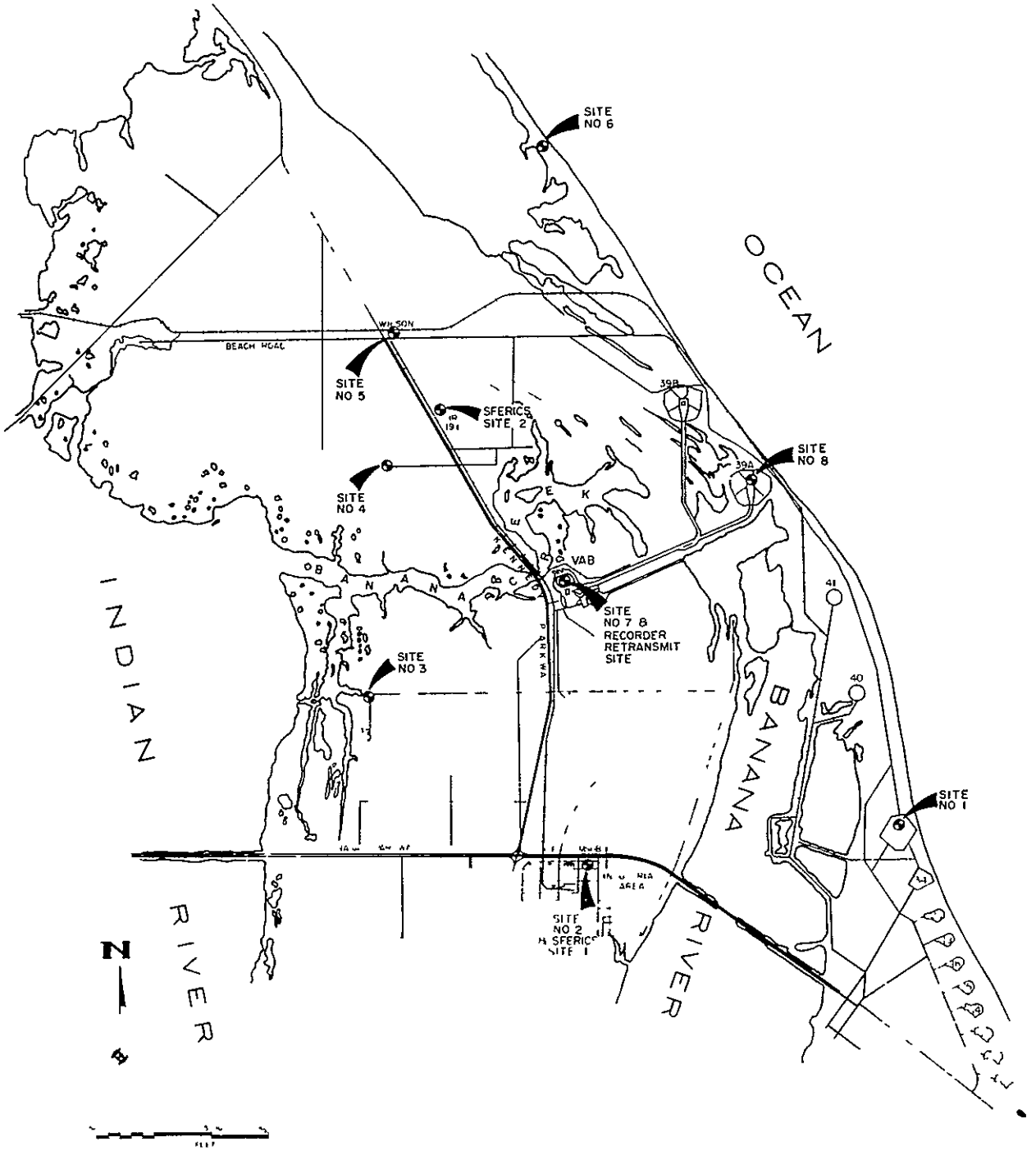

Figure 1-1. LWS Measurement Sites of KSC

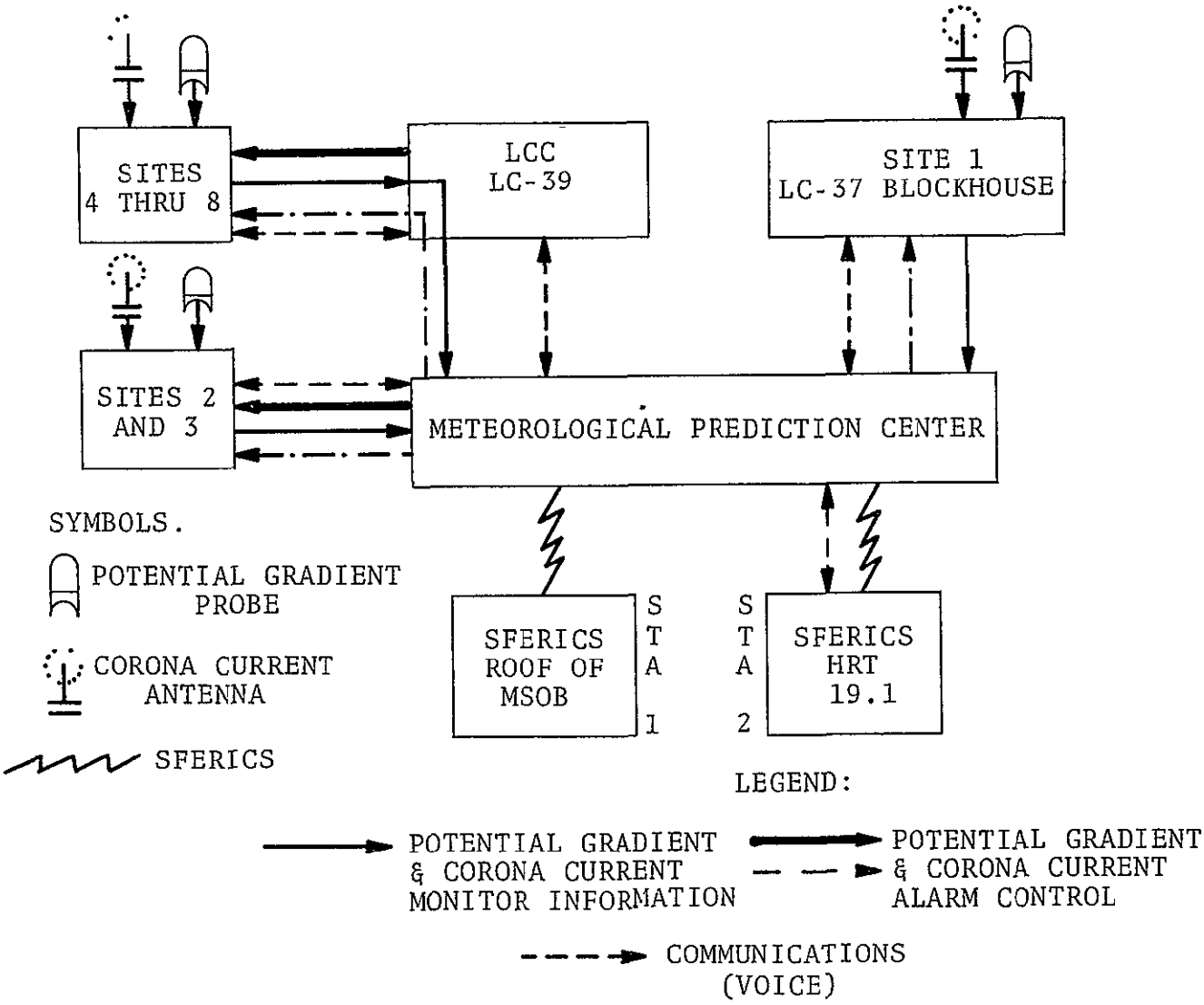

Figure 1-2. Flow Diagram of LWS Information

1.2 SCOPE

The procedures contained in this manual are to be followed for general setup and operation of applicable units of the LWS as designated by Information Systems, Measurement Systems Division (IN-MSD). Conditions of operation for specific missions (e.g ,

launch support) will be outlined in directives covering such operations.

1.3 APPLICABLE DOCUMENTS

The following documents contain information on the LWS.

TR-107-1	Lightning Detection Warning Systems on Saturn Launch Complexes 34, 37, and 39.
KSC-SPEC-M-0007	Lightning Instrumentation Systems At KSC, Specification For
KSC-SPEC-M-0013	Measurement Systems Division Instrumentation At The Meteorological Prediction Center, Specification For
PC-LMS-0001	Allocation Document, KSC Meteorological/Lightning Monitoring Systems
PC1-1753	Indentured Drawing List, Meteorological/Lightning Monitoring System
GP-221	Launch Complex 37 Lightning Effects Analysis

SECTION II

LOCATION AND DESCRIPTION OF THE LIGHTNING WARNING SYSTEM (LWS)

2.1 SENSOR LOCATIONS

The locations of various LWS sensors and antennas are listed in table 2-1. The sensing elements detect potential gradient, corona current, and frequencies emitted by sferics (lightning discharges). As may be seen in figure 2-1, Sites 1 and 4 through 8 PG and CC measurements go to launch control centers and then to the MPC, Sites 2 and 3 are hardlined directly to the MPC. PG alarm threshold control for Site 1 is the function of LC-37, while LCC operators control PG alarm threshold for Sites 4 through 8, the MPC controls alarm threshold for Sites 2 and 3 PG measurements, monitors alarm occurrences for the remaining PG sites, and exercises alarm threshold control for all eight CC measurements. Sferics measurements are cabled to the MPC directly from Sferics Station 1 antennas atop the MSOB and, via an A2A transmission system, from a portable equipment shelter at Sferics Station 2

2.2 READOUT UNIT LOCATIONS

Measurement information from LWS sites and stations is hardlined to central monitoring points The central points are equipped to monitor various LWS measurements as follows

LC-37 Blockhouse - receives PG from Site 1. (CC measurement is routed directly to the MPC.)

LCC - receives PG and CC measurements from Sites 4 through 8

MPC - receives PG and CC measurements from Sites 1 through 8 (Site 1 via LC-37, Sites 2 and 3 directly, Sites 4 through 8 via the LCC).

- receives Sferics measurements from Stations 1 directly and from Station 2 via a portable equipment shelter and A2A wideband transmission system.

Sferics Station 2 Portable Equipment Shelter - receives Sferics measurements from Station 2 sferics antennas mounted on the roof and adjacent to the shelter

Table 2-1. Remote Site Locations

Site	Location
Sferics Station 1	MSOB, highest bay roof; 4.3 miles S of Vehicle Assembly Building (VAB).
Sferics Station 2	High Resolution Tracking Station 19.1, 1/8 mile E of Kennedy Parkway, 3.4 miles NW of VAB.
PG and CC Site 1	LC-37, on roof of blockhouse, 6.5 miles SE of VAB.
PG and CC Site 2	Roof of MSOB, directly over MPC, 4.3 miles S of VAB
PG and CC Site 3	At end of Frequency Analysis (FCA) Road, 2.7 miles W of Kennedy Parkway, 3.5 miles WSW of VAB.
PG and CC Site 4	At end of Sharkey Road, 1.1 miles W of Kennedy Parkway, Camera Site J-5-1241.
PG and CC Site 5	SW corner of intersection of Route 42 (Beach Road) and Kennedy Parkway, 5 miles NW of VAB.
PG and CC Site 6	Playalinda Beach; 8.2 miles N of VAB, Camera Site F-6-2325.
PG and CC Site 7	Roof of VAB.
PG and CC Site 8	LC-39, on Pad A (concrete slab at ground level), 3.3 miles ENE of VAB.

A brief description of each central point follows. It should be noted that interface (terminal distribution) points are not included unless such points are installed in racks where monitor units are located. Refer to the Indentured Drawing List cited in paragraph 1.3 for cabling information.

2 2 1 Launch Complex 37 Blockhouse (LC-37). One PG monitor unit is installed in Rack D41 located on the second floor of the LC-37 Blockhouse. The unit, a Sweeney Master Control Panel provides PG Site 1 readout and alarm control capability

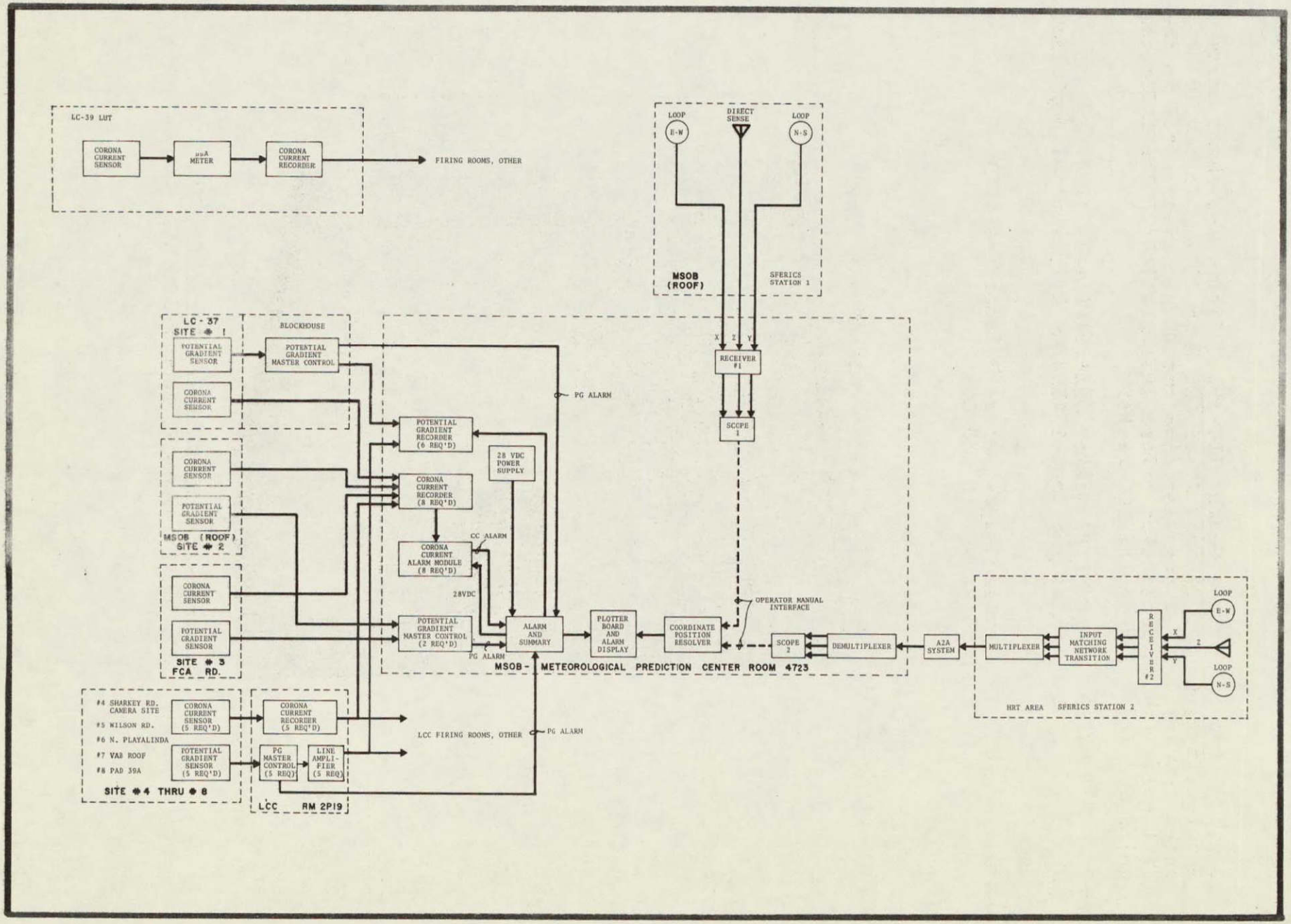

Figure 2-1. LWS Block Diagram

2.2.2 Launch Control Center (LC-39). Figure 2-2 shows units located in Racks 27, 28, and 29 of LCC Room 2P19. It should be noted that figure 2-2 does not show the CC recorders cited in the list below (photograph taken before installation). The following units are installed in the LCC racks:

PG 5 Sweeney 1193 Master Control Panels (PG)
5 Dynamics Inc. model 7504/MP Differential Amplifiers (PG)

CC 5 Esterline Angus Series S Recorders (CC)
1 Patch Panel (PG and CC)

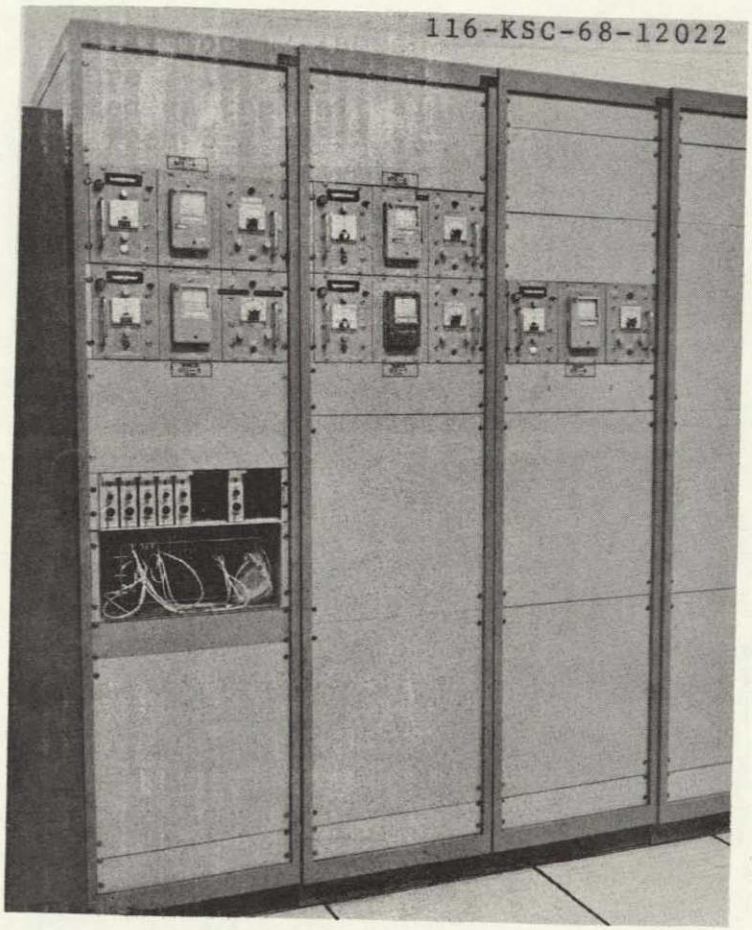

Figure 2-2. LWS Units of Racks 27, 28, and 29, Room 2P19, LCC

2.2.3 Meteorological Prediction Center (MPC). Figure 2-3 shows LWS units installed in Racks 2, 3 & 4, and the Milgo Plotter Console of MSOB Room 4723 (MPC). An elevation block diagram of units is shown in figure 2-4. Note that units housed in Rack 1 and a portion of Rack 2 are not covered in this manual because the units apply to meteorological (weather) measurements.

2.2.4 Sferics Station 2 Portable Equipment Shelter. Figure 2-5 shows the equipment rack located inside the portable equipment shelter at Sferics Station 2. The following units are located in the rack:

1 Sferics Receiver, ARI Type SF-44
1 Voltage Divider (Transition) Panel
3 Voltage Control Oscillators*
1 Time Delay Module*
2 Frequency Summing Units*
1 ±16Vdc Power Supply*

Multiplexed signals are routed via coaxial lines to an A2A amplifier located at the bottom of the rack. The output of the amplifier is cabled to the right wall of the shelter where terminal connectors tie the cables to underground lines for passage to the A2A windband transmission system and then to the MPC.

2.2.5 Special Local LWS Measurements. Each launch complex has additional requirements for LWS measurements. At present, the additional requirements call for CC measurement installations on Launch Umbilical Tower (LUT) structures, but requirements may be expanded to include PG installations. Readouts are designed for local (launch complex) support. LWS information is made available to control centers and firing rooms at the complex where installed and is not relayed to the MPC.

2.3 SFERICS MEASUREMENTS

Sferics involves the detection of lightning discharges between charged bodies such as clouds and structures or natural objects. A lightning discharge propagates static bursts that are received by antenna arrays at each of two sferics stations. Each sferics array consists of two loop antennas for direction-finding purposes and a direct sense antenna for resolving the quadrant of sferics origin. Receivers amplify the bursts associated with a lightning stroke and, in the case of Sferics Station 2, receiver outputs are multiplexed and pass to the MPC via hardlines where the information is demultiplexed and applied to an oscilloscope. The output of Sferics Station 1 is fed directly

* Components of ADTS-4 transmission system

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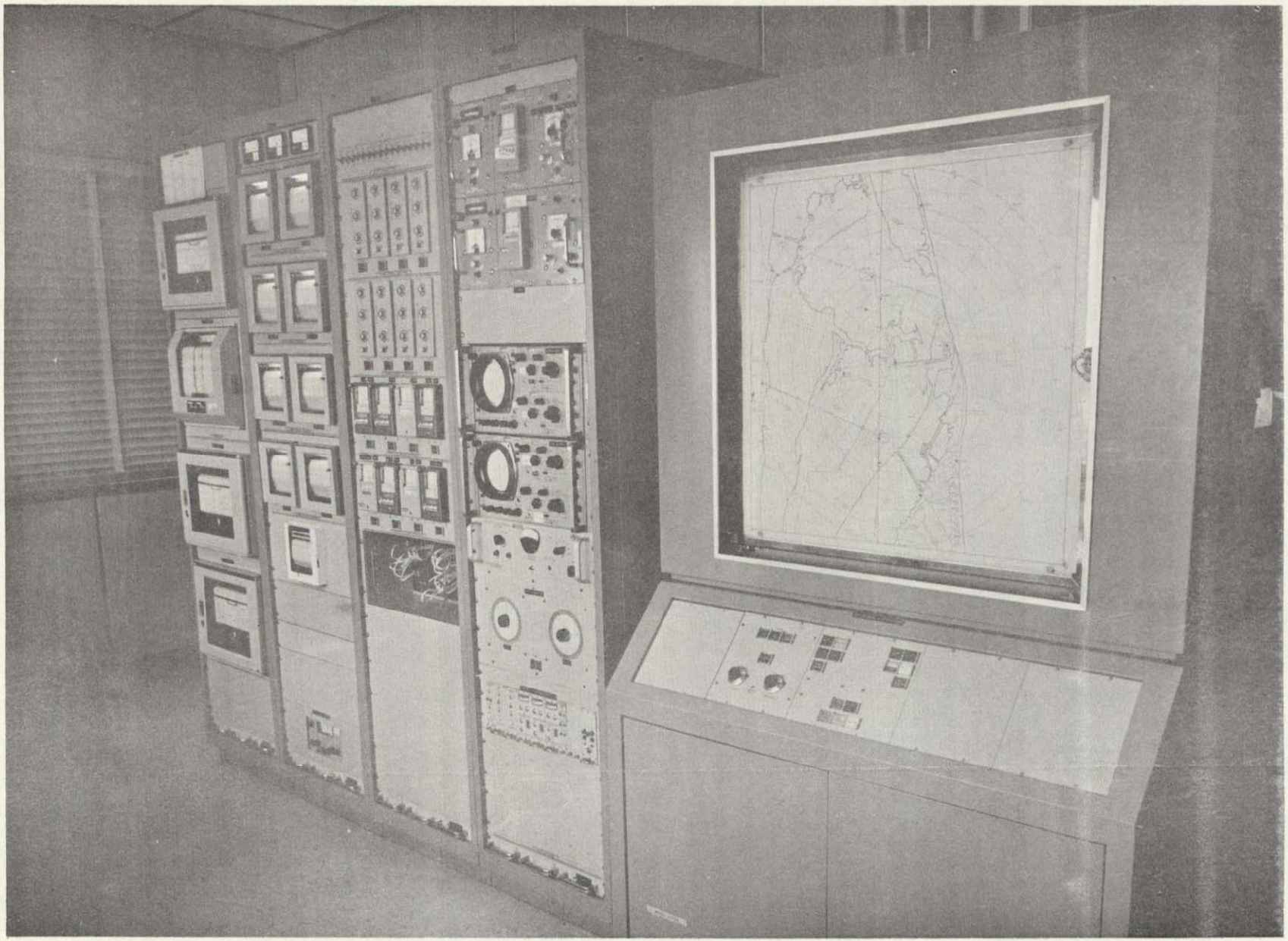

Figure 2-3. Equipment Racks 1, 2, 3, 4, and Milgo Console at the MPC

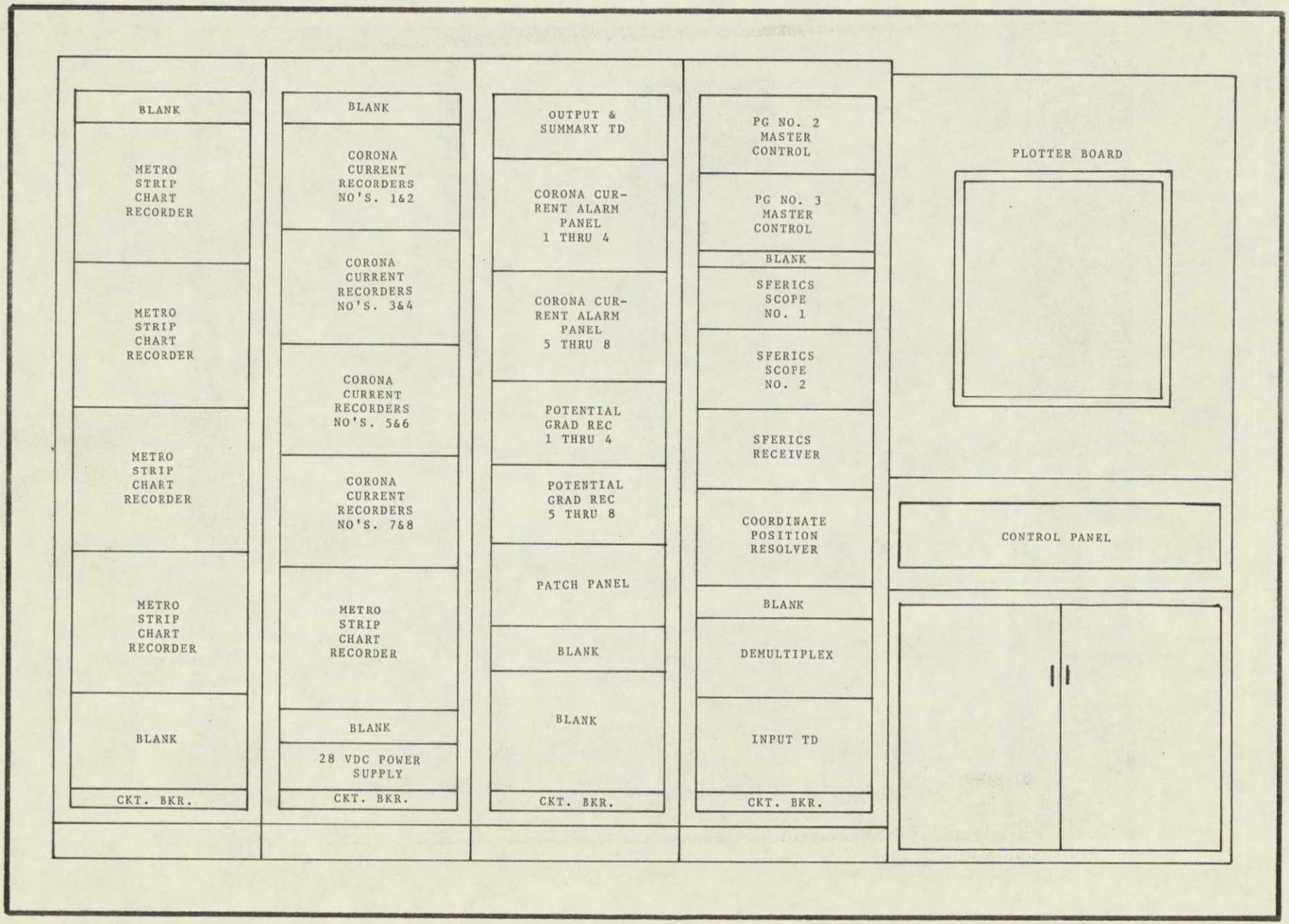

Figure 2-4. Rack Placement of MPC LWS Units

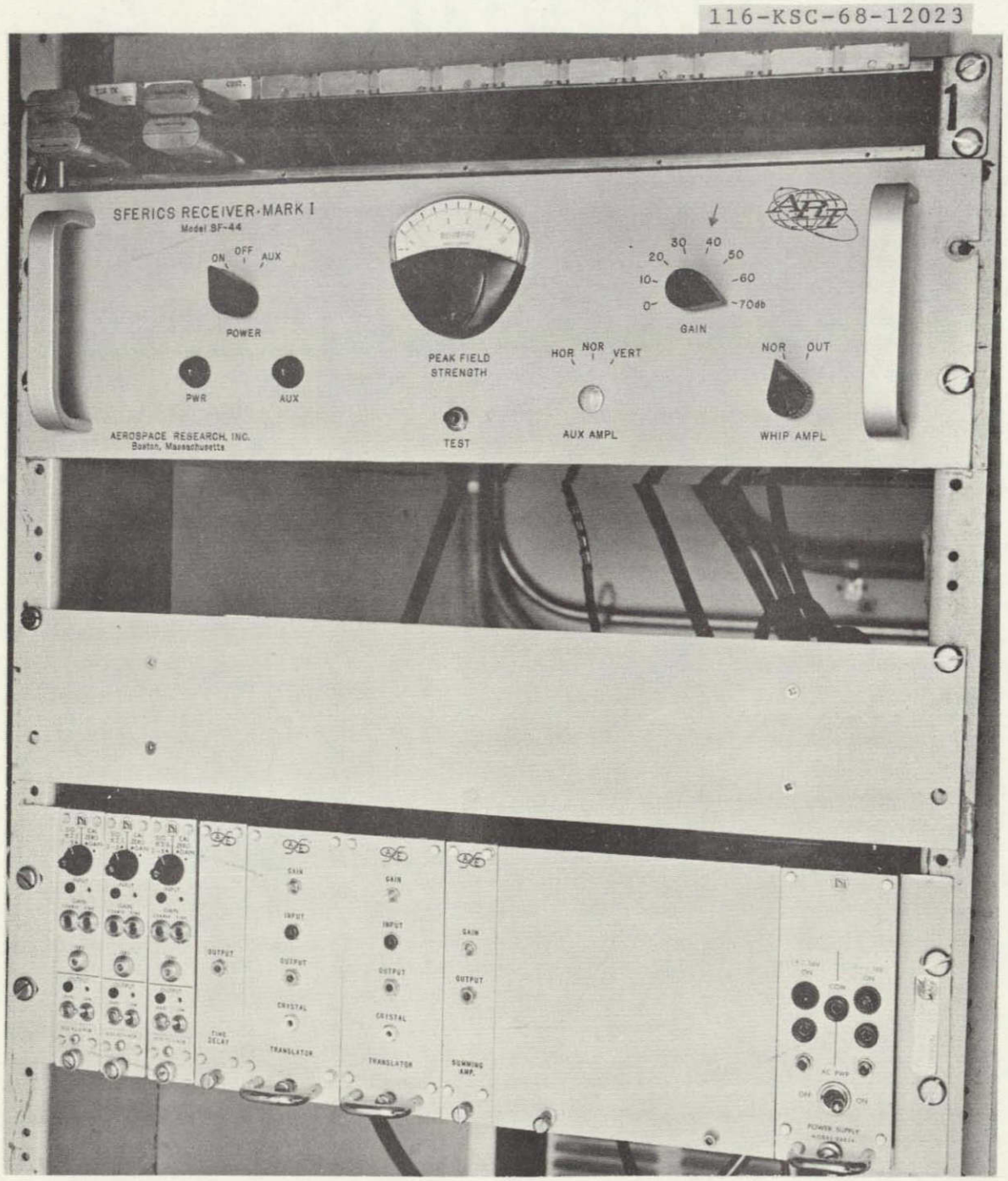

Figure 2-5. Sferics Station 2, Portable Equipment Shelter Equipment Rack

from the receiver to Scope 1 of the MPC. An operator stationed at the sferics oscilloscopes then manually dials the particular coordinate displayed on the scopes into a position resolver. The position resolver controls the x, y coordinates of a plotter board arm, and when the two station coordinates are entered and the arm activated, a pen mechanism automatically swings to the intersecting point and marks the point on the map. After a series of discharges are triangulated and marked, a pattern, or storm path, emerges on the special-design map of the plotter board. The system is designed to plot the path of a storm in ranges of 20, 40, 100 miles, the 100-mile range representing a 50-mile radius of the sferics stations.

2.3.1 Sferics Antennas. The antennas of sferics stations are mounted on the roof of the MSOB (figure 2-6) and atop a portable equipment shelter at the High Resolution Tracking Site (Station 19.1), 7.4 miles NNW of the MSOB. Each station has an antenna array consisting of two loops and a sense antenna. One loop antenna is North-South-(true) oriented and the second loop is East-West-(90- and 270-degrees) oriented. The sense antenna is used in resolving 180-degree ambiguities, thereby providing a direction-finding capability to fix the azimuth of lightning discharges. The two arrays provide the azimuths necessary to triangulate the point at which a lightning discharge occurs. Signals received by the antennas are fed to receivers for amplification of frequencies in the sferics spectrum.

2.3.2 Sferics Receivers. The receiver for Sferics Station 1 is housed in MPC Rack 4 (figure 2-7); the Station 2 receiver is located in a portable equipment shelter at the station. The receivers are ARI type SF44 receivers and are designed to detect signals in the 1-30 kHz range, the spectrum associated with sferics. Provision is made to control gain of received signals as storms approach, and a meter circuit of the unit monitors the relative strength of sferics activity within the spectrum.

At Station 1 sferics static bursts received by the loop antennas and detected by the receivers are amplified and applied to vertical and horizontal deflection plates of an oscilloscope used to display sferics for the station. The output of the sense antenna is delayed 90 degrees and applied to the scope beam unblanker circuits for resolving 180-degree ambiguities. Provision is made to disable the blanking action by operator control when required.

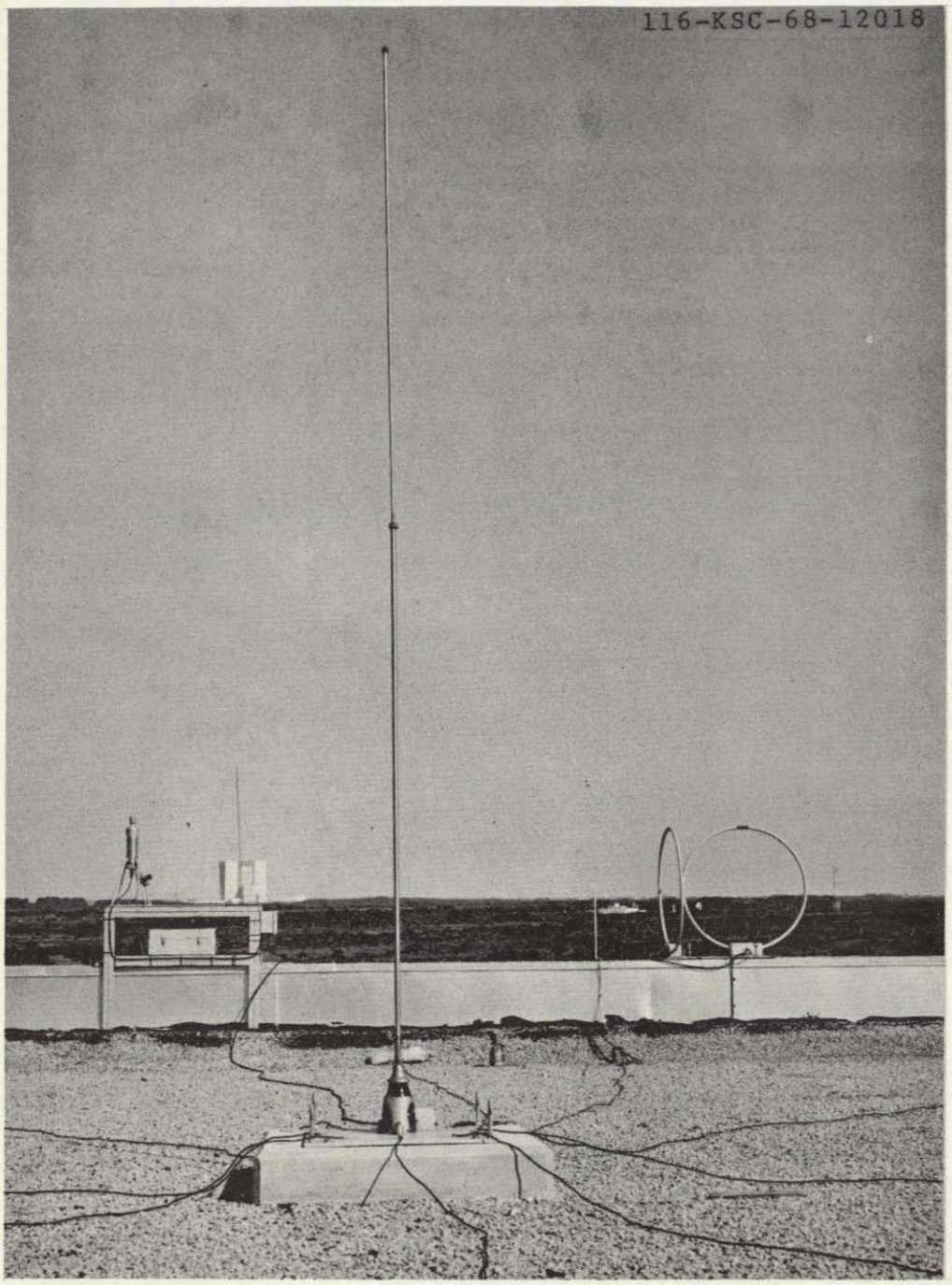

Figure 2-6. Sferics Station 1 Sense (foreground) and Loop (right background) Antennas

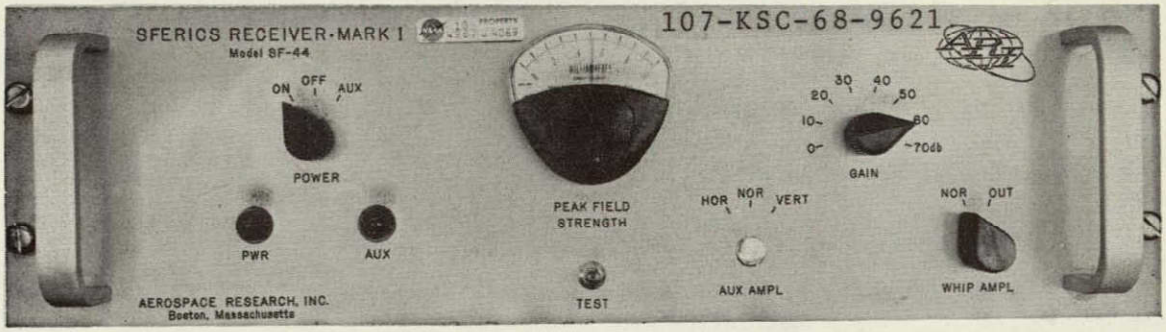

Figure 2-7. Sferics Receiver

Because of distance, the outputs of the sferics receiver at Station 2 are multiplexed, passed via an A2A transmission system, to the MPC for demultiplexing and application to an oscilloscope. The receiver gain control of Station 2 is preset to apply to general sferics conditions.

2.3.3 Sferics Station 2 Multiplexer and MPC Demultiplexer Units. To achieve an accurate reproduction at the MPC of analog outputs of the sferics receiver of Station 2, the respective outputs are applied to voltage-controlled oscillators (VCO) at the station. This action transforms the analog levels to corresponding frequency modulated signals which are then multiplexed and applied to the A2A transmission system for relay to the MPC. Multiplexing the signals makes the response frequency-dependent as opposed to level-dependent and eliminates special concern for transmission line loss and pickup. Units located at the MPC demodulate the received signals and discriminator units restore them to the original analog levels before application to deflection and unblanking circuits of the Sferics Station 2 oscilloscope.

Units used to demultiplex the multiplexed outputs of the Station 2 receiver are located in Rack 4 of the MPC (figure 2-8).

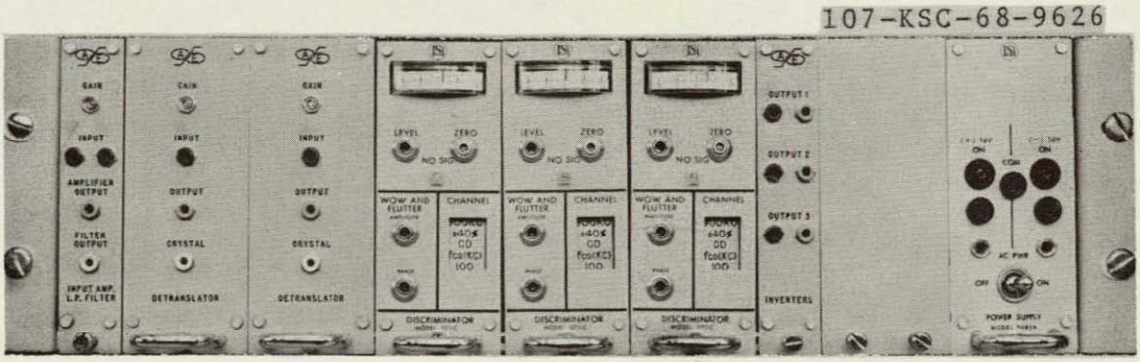

Figure 2-8. Sferics Station 2 Demultiplexer Units (MPC Rack 4)

All units are located at one level and consist of 3 discriminators, 2 detranslators, 1 input amplifier/low pass filter, 1 inverter, and 1 ±16Vdc power supply units.

2.3.4 Sferics Display Oscilloscopes. Two modified HP Model 141A oscilloscopes (figure 2-9), mounted in MPC Rack 4, provide visual display of sferics as associated with the detection networks of the respective stations. Signal inputs are applied to Type 1400A Differential Amplifier Plug-In units which apply the receiver outputs to the deflection plates of the scope CRT for display of station coordinates of lightning strokes. The scopes present variable, long-persistence traces to allow operators to determine the point of lightning strokes with respect to the station locations. The faceplate of each scope is etched with graticules representing 10-degree increments with respect to true North (0 degrees). The center point of the faceplate represents the location of the particular station which the scope is monitoring. Indications on the two scope faces allow operators to determine azimuths of sferic activity and provide a manual interface between the plotter board (via a position resolver) and the sferic stations.

2.3.5 Coordinate Position Resolver. The resolver unit (figure 2-10) is housed in MPC Rack 4 and provides control of the plotter board pen position on an x, y basis. The resolver units contain two vernier controls that provide for manual interface between azimuths displayed on the sferics scopes and the plot marked on the plotter. The control/indicator pushbutton located in the lower center of the unit notifies the operator if the plot is beyond range (LIMIT) and, when depressed, activates the plotter arm to mark plots. Azimuths observed on the oscilloscopes are dialed onto the vernier controls by operators. The resulting outputs of the resolver represents the triangulated vector point of a particular detected stroke. The outputs drive the x axis and y axis pen servos that position the plotter pen above a point on the map representing the sferics source. The point is automatically marked when the operator depresses the PEN pushbutton.

2.3.6 Milgo Plotter Board. The plotter board (figure 2-11) is a modified Milgo Model 4020A unit constructed in the console immediately to the right of Rack 4 in the MPC operations room. The upper portion is the map display area and contains the plotting arm mechanism. The center portion of the console contains operating controls, and the lower portion houses drive motors, a vacuum motor, circuits, and adjustable components for plotter board function alignments.

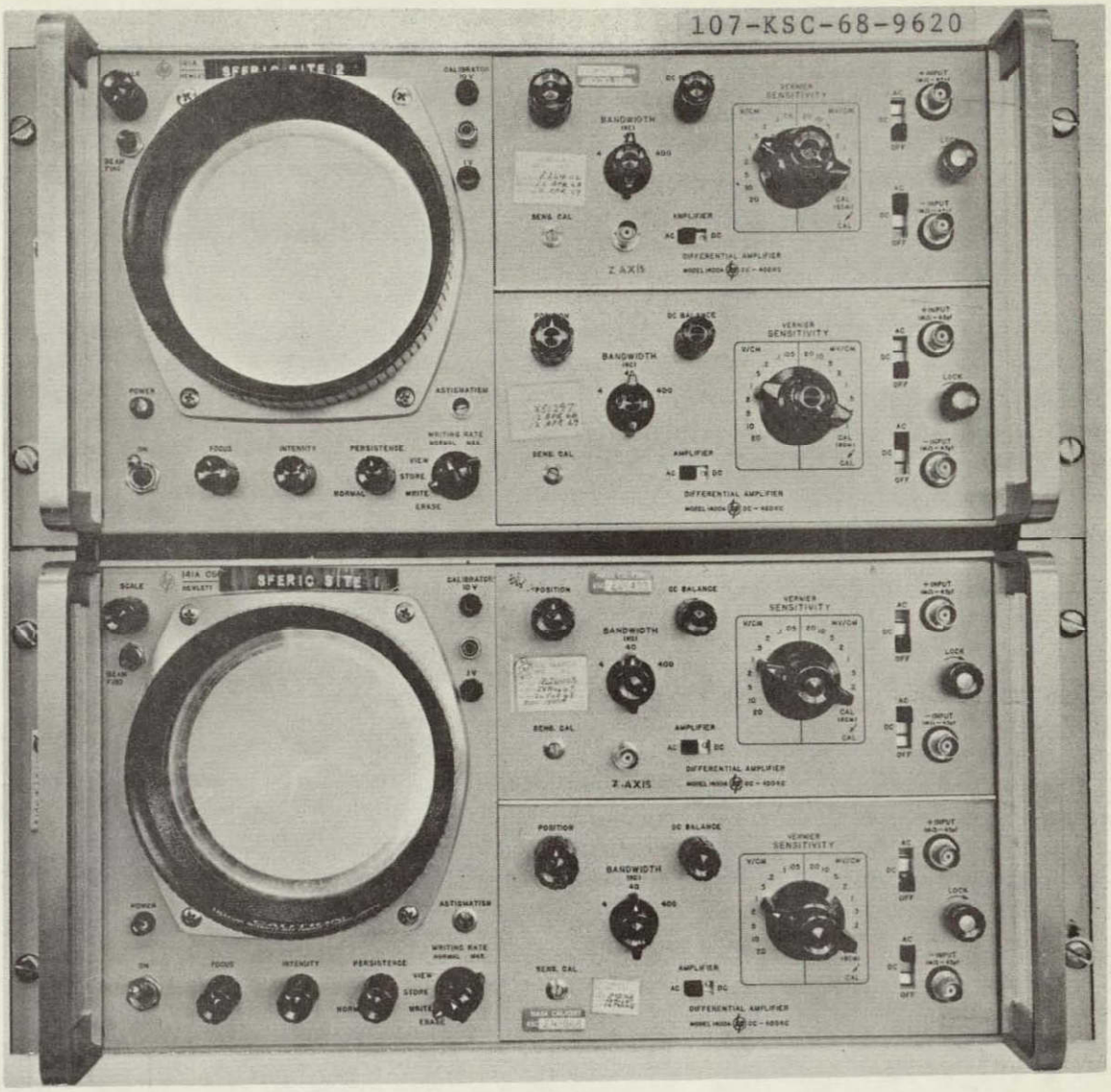

Figure 2-9. Sferics Display Oscilloscopes and Differential Plug-in Units

The plotter, designed to cover three ranges (20, 40, 100 miles), is presently operational in the 20-mile range only. A map is held in place by a vacuum system, with provision to hold the map in place by using small magnets at each corner. Either of two pens (red or green) may be used to mark sferics plots. The pens are mounted side-by-side on a servo-driven arm that covers the x and y positions of plots.

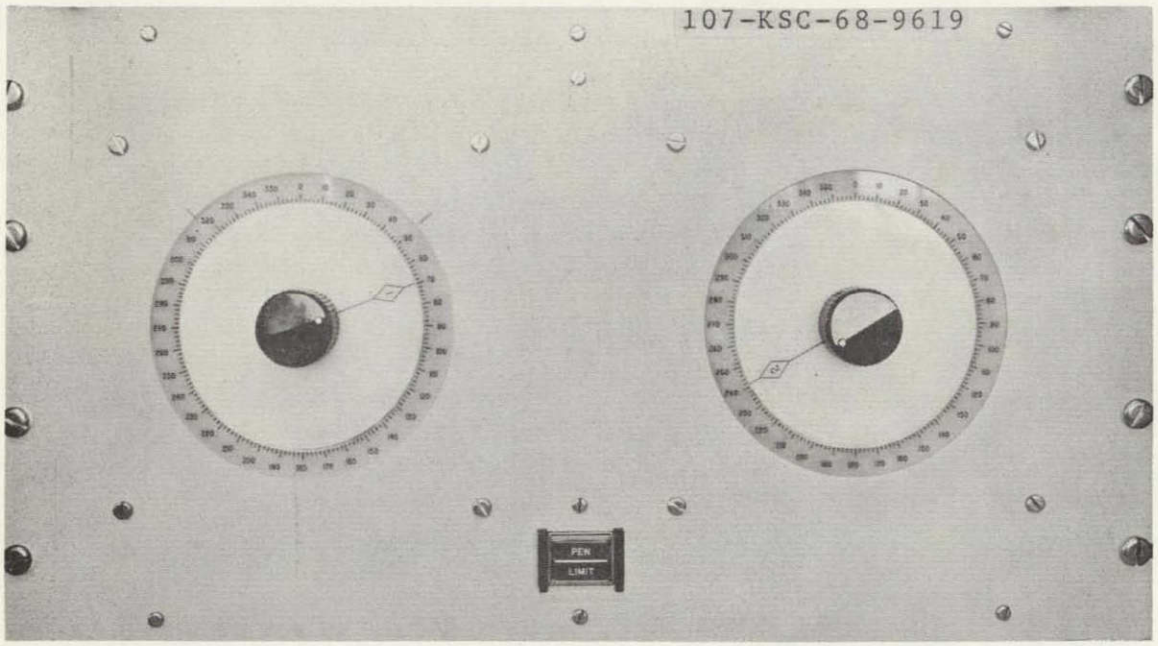

Figure 2-10. Sferics Coordinate Position Resolver

Controls located on the center portion of the plotter console provide for activating the unit, applying dc power, and turnon of the vacuum system. Controls on the upper-left portion of the center panel allow the operator to place the unit in a standby or operate status, provide two plots for parallax check-out, and shift control for marking plots to the coordinate position resolver unit. Switches at the upper-right portion of the panel control pen marking and determine which pen will mark plots. The AUTO LIFT switch is used with the pen DOWN and status OPERATE switches to provide automatic marking action. The PEN REMOTE switch is not used. The TIMING and POINT PLOT switches of the panel are a future capability function, not presently used.

Switches and controls mounted on the panel to the left of the center panel provide for calibration of arm travel to two points of the map used to plot sferics occurrences. Two controls are heliopots for fine adjustment of x and y parallax. A screwdriver adjustment (DISTANCE SCALE) provides fine control of arm travel when maps (and ranges) of the plotter are changed.

The switches described in the previous paragraphs are pushbutton/indicator switches of three types; locking, non-locking, and momentary. A locking switch holds a function until the switch is depressed a second time. A non-locking switch either mechanically or electrically interlocks a second switch for enabling or disabling a function. A momentary switch must be held depressed to perform a function.

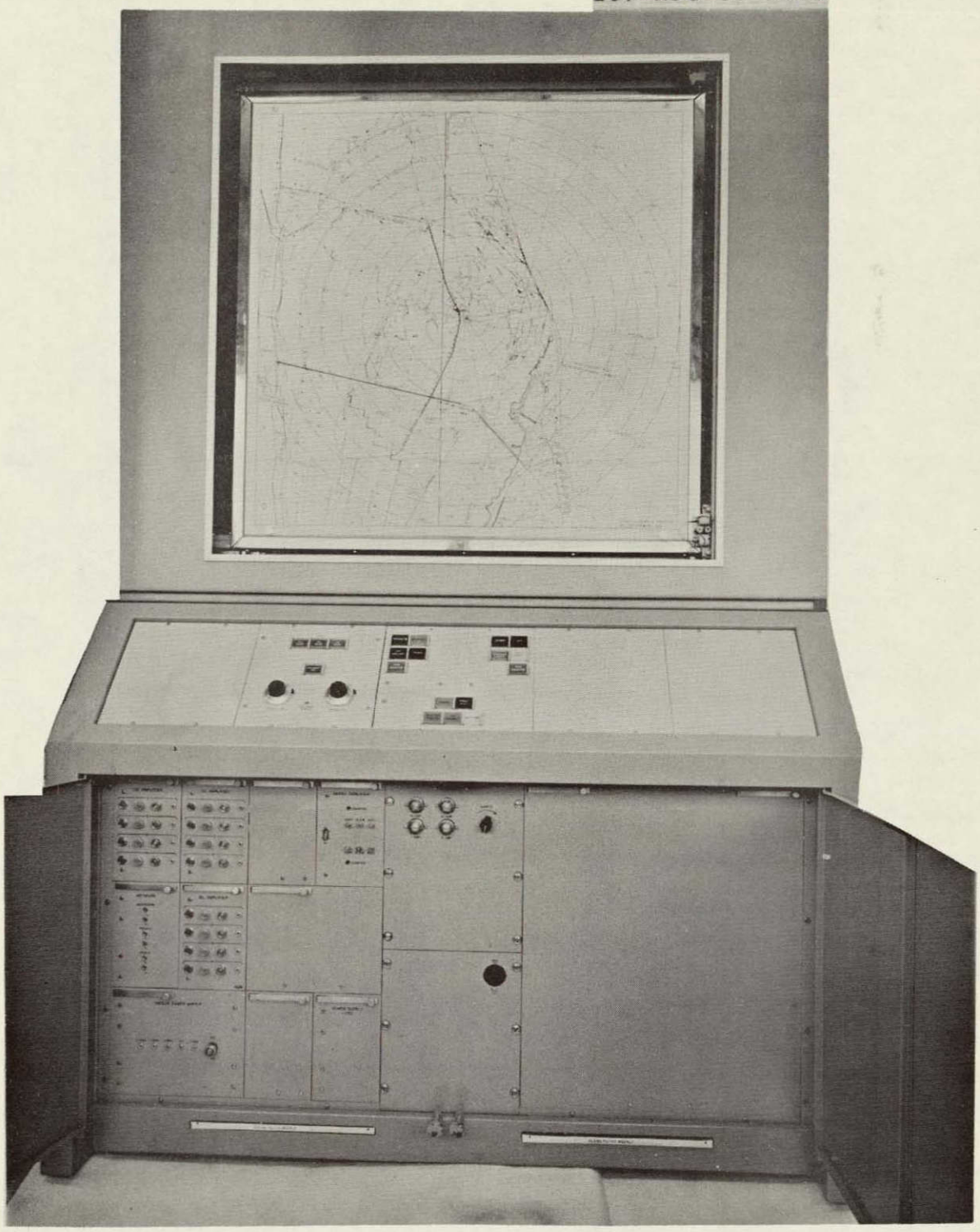

Figure 2-11. Plotter Board Assembly (front access doors open)

Adjustable controls located in the lower portion of the console are primarily alignment controls used for board function calibration. Operating procedures cover differential amplifier balancing, but the remaining adjustments are made at the factory and should not be changed. Test points are provided in the lower console to check levels of the plotter dc power supplies.

2.4 POTENTIAL GRADIENT MEASUREMENTS

Potential gradient (PG) probes at remote sites use a radioactive (tritium) sensor (figure 2-12) to determine the relative level and polarity of charged bodies (usually clouds) within a 20-mile radius of the sites. Level and polarity information is hardlined via telephone lines to LC-37, LCC, and the MPC. Site 1 measurements go to LC-37 for monitor purposes; parallel lines carry Site 1 information to the MPC for recording and alarm display. Sites 2 and 3 PG measurements are hardlined directly to the MPC for monitoring, recording, and alarm threshold control. Sites 4 through 8 PG measurements are wired to LCC 39 for monitoring, recording, and alarm threshold control functions and are relayed to the MPC via line amplifiers for recording and alarm display. Units used to monitor, record, set alarm control, and display alarms are described in paragraphs that follow.

2.4.1 Potential Gradient Recorders. Rustrak Model 88 recorders are used to record PG measurements. Eight recorders are mounted in two equipment panels of Rack 3 at the MPC (figure 2-13); six recorders actively record PG information from six sites and two recorders are spares. The remaining two sites measurements (2&3) are recorded by units located in two PG Master Control panels which are described in paragraphs that follow. The recorder inputs to the MPC are by way of a patchboard (PB3) of the Patch Panel located immediately below the recorders. A control/indicator pushbutton located beneath each recorder is used to apply power to the unit and, by lamp indication, notify MPC operators that the preset alarm level has been reached or exceeded at the site.

The recorders are preset to operate at a desired speed by the installation of an appropriate drive mechanism. Operators must install time-annotated chart rolls to agree with preset drive mechanisms. As installed, the recorder chart travel rate is one inch per hour, giving a chart life of one month. The chart paper is pressure-sensitive and is marked by a striker mechanism and stylus. The chart paper provides a 3-inch-wide marking area, the center line representing zero PG response of the remote sensor. The left margin represents +15 kV/m of PG while the right margin represents -18 kV/m of PG. The nominal range of the recorder is 0 to 100 μA. The recorder is provided with a mechanical interlock to stop marking action when in the servicing position.

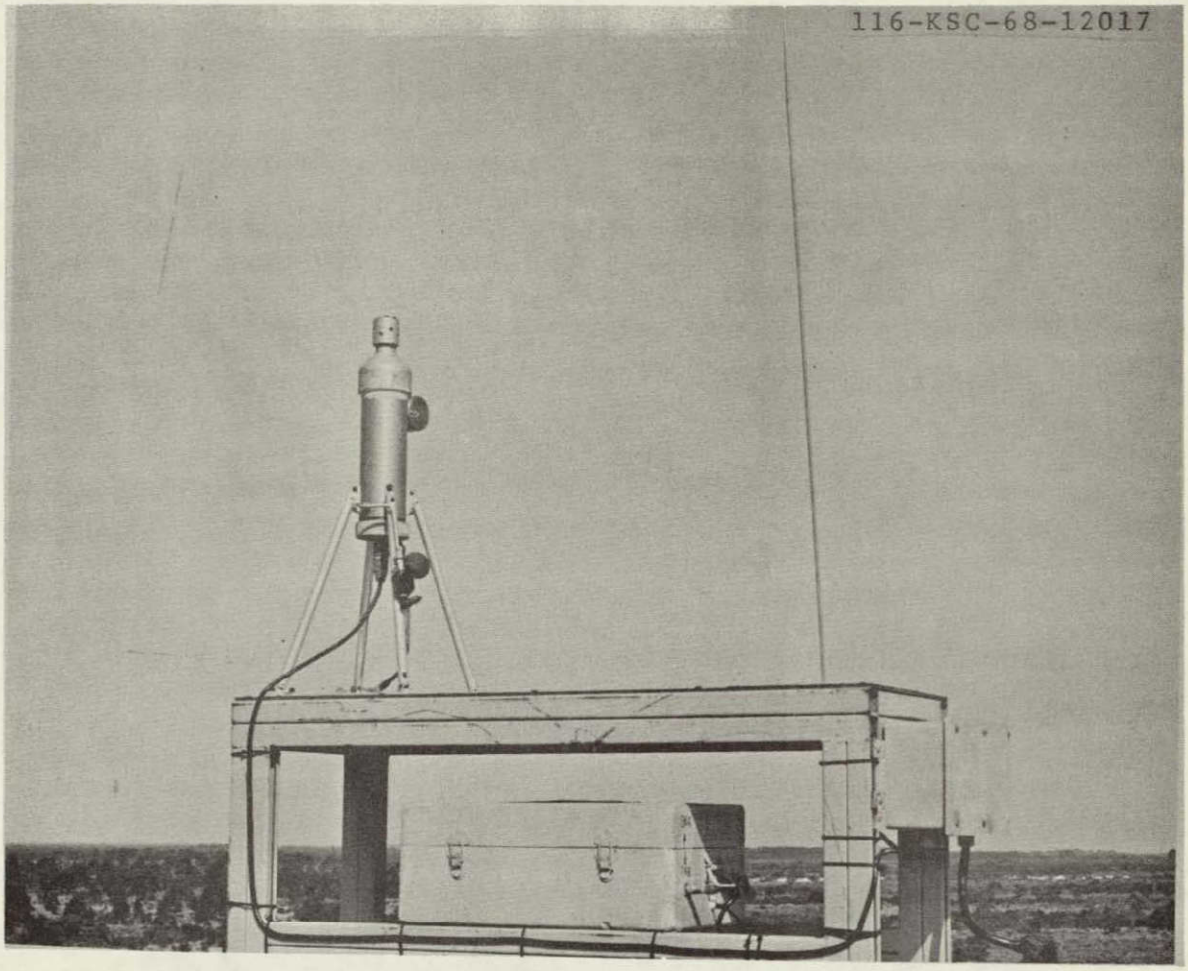

Figure 2-12. Closeup of PG Sensor, CC Whip Antenna, and CC Battery Pack/Amplifier Assembly

2.4.2 Potential Gradient Master Control Panels. Power application to the PG sensors and control of alarm indications of the eight PG sites is exercised by way of master control panels. In addition, a master control unit provides meter readings for probe current, PG level, and rate of change and contains a recorder (identical to those of the PG Recorder panels). The control units are Sweeney Models 1193 or 1193A and are assigned as follows:

LC-37	Site 1 PG control
MPC	Sites 2 and 3 PG control
LCC	Sites 4 through 8 PG control

The two types are almost identical functionally, but differ somewhat physically, and are described below.

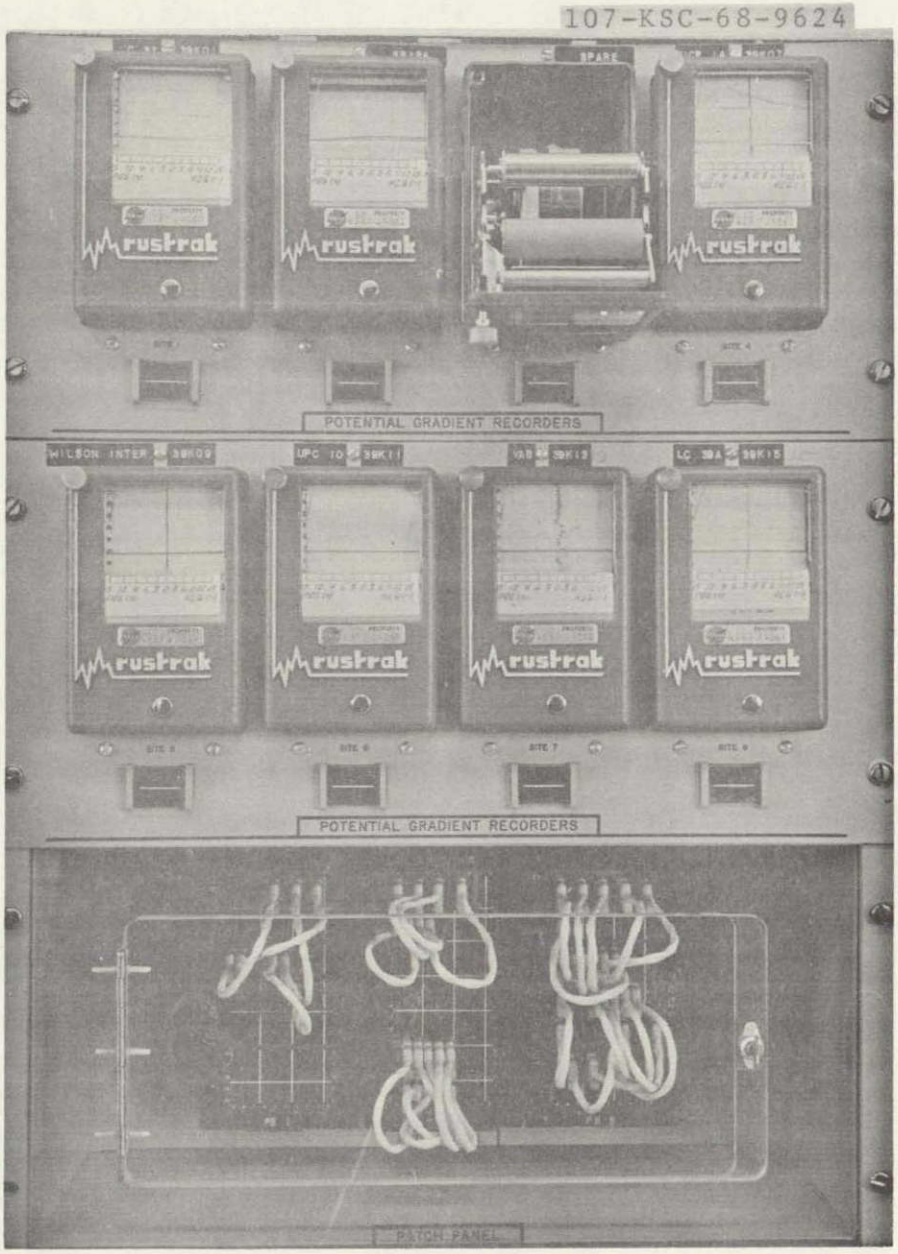

Figure 2-13. PG Recorders (one recorder shown in servicing position) and Patch Panel (beneath)

2.4.2.1 Master Control Model 1193. The model 1193 control unit is made up of three subunits mounted on a 19-inch panel (figure 2-14). Table 2-2 lists control/indicator functions performed by the subunits.

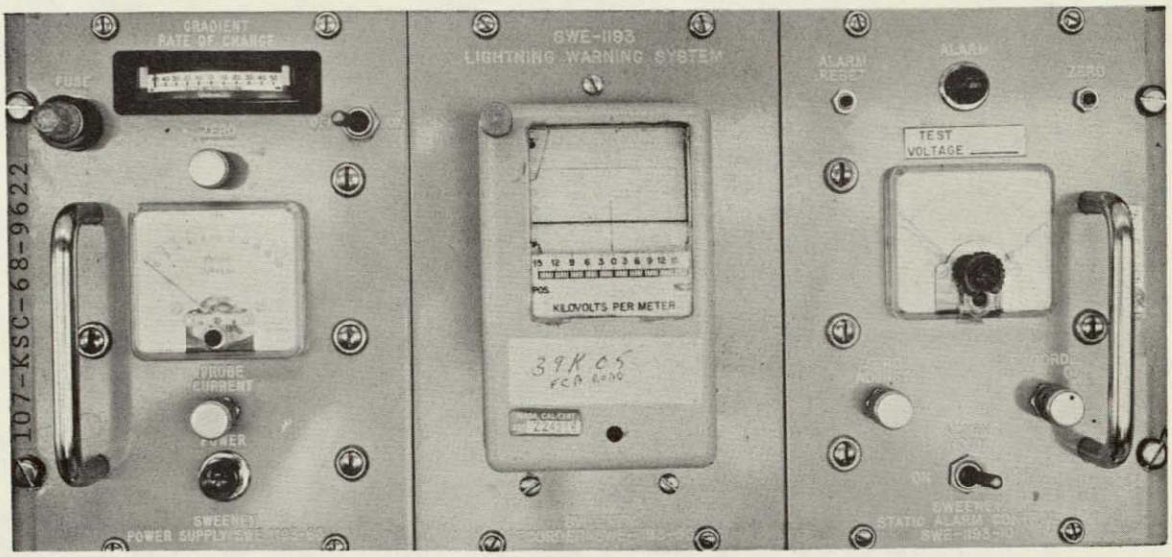

Figure 2-14. PG Master Control Panel Model 1193

Table 2-2. Model SWE 1193 Controls and Indicators

Subunit	Control Indicator	Function
SWE-1193-60	POWER SUPPLY	Provide Probe Power
	FUSE	Line Protect
	GRADIENT RATE OF CHANGE (meter)*	Readout of rate of change of PG in volts per meter per second.
	Power ON/OFF (switch)	Main Power Switch
	ZERO (adjust)	Zero adjust for gradient change meter.
	PROBE CURRENT (meter)	Readout of probe current applied to probe sensor (Sweeney 1196)
	PROBE CURRENT (adjust)	Set probe current to SET level of meter.
SWE-1193-50	RECORDER	Record PG measurement
SWE-1193-10	STATIC ALARM CONTROL	Setting alarm thresholds and indication if threshhold is exceeded.

*No present requirement for calibration of measurement availability.

Table 2-2. Model SWE 1193 Controls and Indicators (Cont'd)

Subunit	Control Indicator	Function
SWE-1193-10 (Cont'd)	ALARM RESET ** (pushbutton)	Manual reset of unit after alarm.
	ALARM (indicator)	Flashes when preset alarm level is exceeded.
	ZERO (pushbutton)	Opens PG input line for electrical zero of KV/M meter (test voltage factor)
	KV/M (meter)	Black needle indicates PG level and polarity. Red limit switches (needles) for preset levels of alarm indication.
	RECORDER ON/OFF (switch)	Apply power to recorder
	ALARM HORN ON/OFF (switch)	Provides audible alarm in ON position when preset alarm level exceeded.
	ZERO ADJUST	Electrical zero adjustment for KV/M meter.

**Unit contains an automatic reset circuit that resets unit in 15 seconds if ALARM RESET option is not used.

2.4.2.2 Master Control Model 1193A. The model 1193A control unit (figure 2-15) integrates on one chassis the functions of the three subunits contained in the Model 1193 Master Control Panel described in paragraph 2.4.2.1. Most of the features described in table 2-2 are incorporated in the newer model, but improved features provide for more versatile operation. The KILOVOLTS PER METER meter uses a test point for setting probe current and, in the function switch CAL position, the test point is used to verify calibration. Calibration controls are normally inaccessible to operators (figure 2-16), but operators will need to use the PROBE CURRENT SET potentiometer to set probe current (to TEST) in the event that probe current is erratic. Other controls located on the main chassis are used in the checkout operations covered in section III.

Figure 2-15. PG Master Control Panel Model 1193A

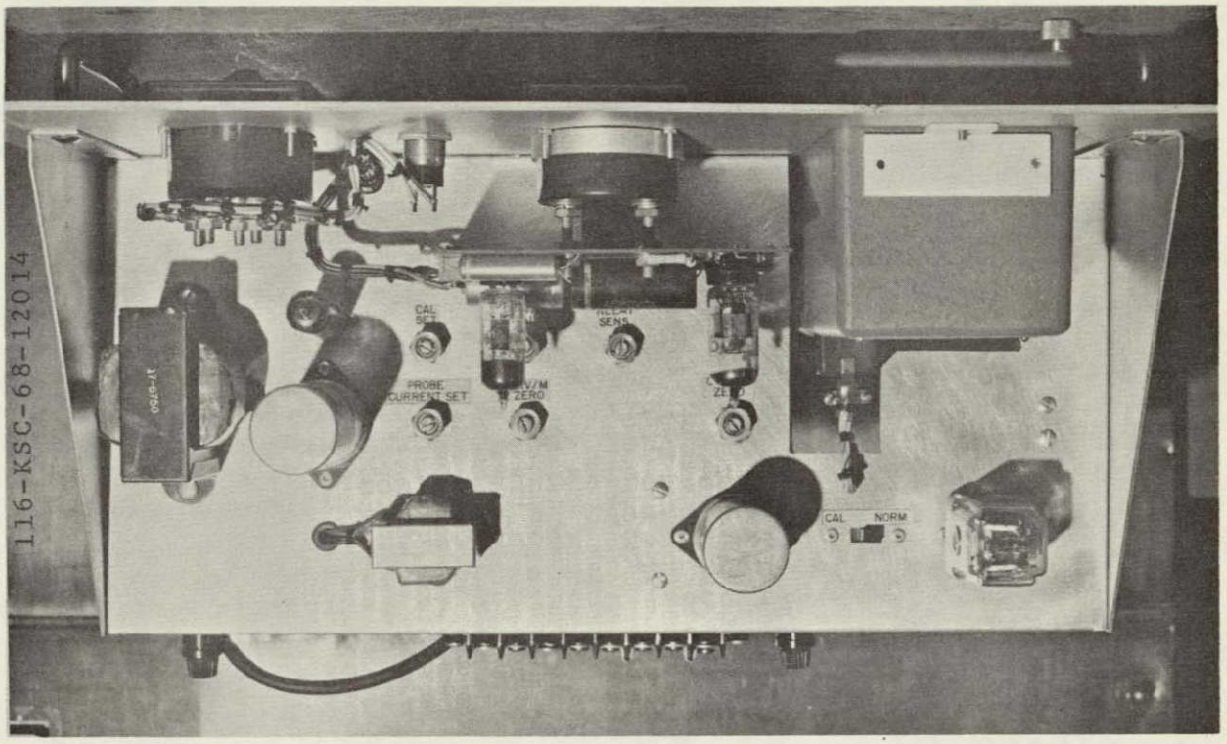

Figure 2-16. Top View of PG Master Control Chassis Model 1193A

2.4.3 Potential Gradient Calibrator Model PGC-1. The PG Calibrator (figure 2-17) is a local-manufactured unit used in checkout of PG measurement components. The calibrator consists of a battery supply and a plexiglas fixture whose anode is connected to the supply via insulated leads. The battery supply assembly contains switches to apply a voltage level to the anode (ON/OFF) and to select the voltage level for checkout (0, 5, 10, and 15 kV/m). Polarity of the voltage level applied is reversed by reversing the high voltage (+) and ground (-) leads. The PGC-1 unit is calibrated in the laboratory in conjunction with a high voltage screen room and protective seals applied to protect calibration integrity. The plexiglas fixture contains the anode and, when the fixture is mounted on the PG probe and voltage is applied, the probe should respond with the appropriate PG level.

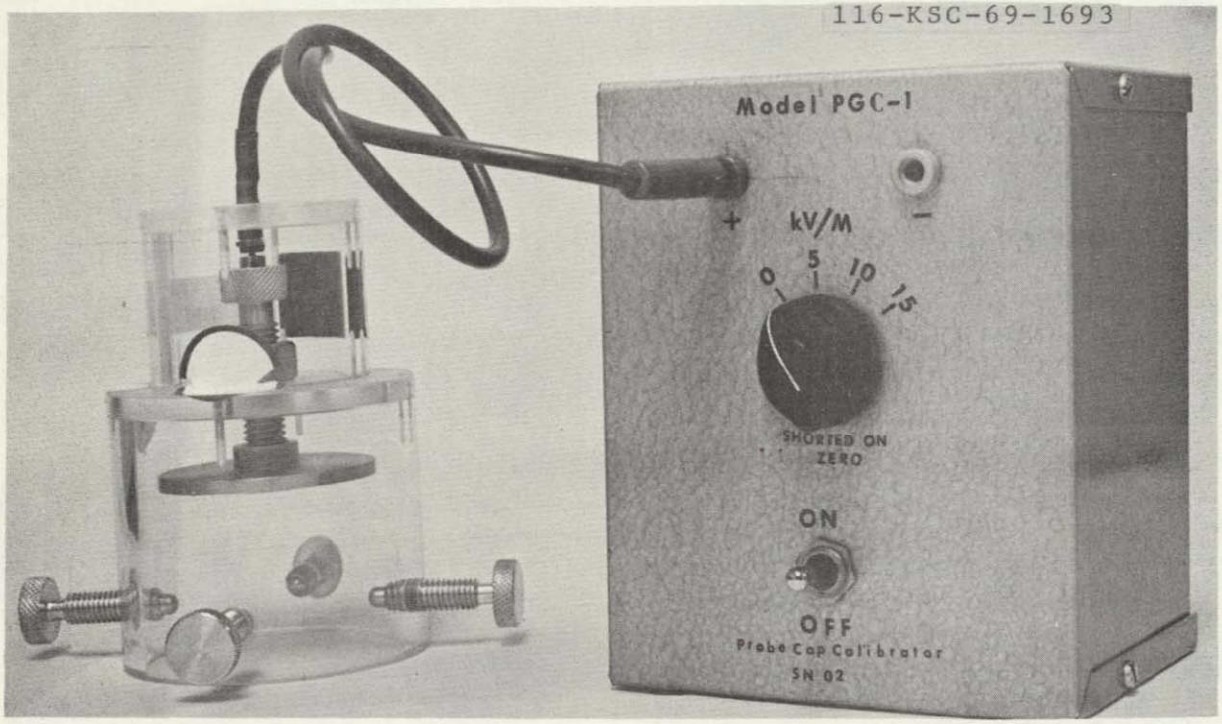

Figure 2-17. Model PGC-1 Potential Gradient Calibrator

2.5 CORONA CURRENT MEASUREMENTS

Corona current (CC) measurements are detected by whip antennas (figure 2-12) at various installations. The current flow is the result of the presence of a charged body breaking down the dielectric between the charged area and ground. The current flow in the air surrounding the whip is applied to a measurement resistor in a site amplifier housed in the battery pack at the site or is applied to a Keithley Model 410 Micro-micro-ammeter containing an amplifier (at LUT structures). The output

of the respective amplifiers are hardlined to recorders (local and/or remote) for permanent records of CC vs time. As in the case of PG, alarm thresholds may be preset to warn of possible hazardous conditions that may be present at the sensor installation.

2.5.1 CC Site Amplifier. The CC site amplifiers are inhouse-manufactured items mounted inside the battery packs located at the CC antennas of the sites. A CC unit is laboratory-calibrated and information recorded on measurement calibration data forms is used by a site technician to set the gain of the amplifier to provide voltage inputs to readout units proportional to a simulated CC measurement. Operators stationed at monitoring points verify recorder responses of the induced voltages.

2.5.2 CC Micro-microammeter Monitors. The Keithley Model 410 is installed at special local (launch complex) sites of the LWS. The instrument (figure 2-18) provides a direct monitor capability. A range switch located on the unit allows for operation at one of 20 settings ranging from 3×10^{-13} to 10×10^{-4} Amperes. A polarity selector control is used to determine polarity of CC inputs and a zero pushbutton and adjustable zero control provide for setting the meter when changing operating ranges.

Figure 2-18. CC Micro-microampere Monitor Unit

2.5.3 CC Recorders. Esterline Angus Series S Recorders (figure 2-19) are used to record CC measurements. Range of the units is determined by input line-to-rear terminal strip hookup. As installed, the units provide a recording range of 0 to ±1.25 volts. A full-scale reading (±1.25V) represents ±12.5 μA of CC flow at the monitored site.

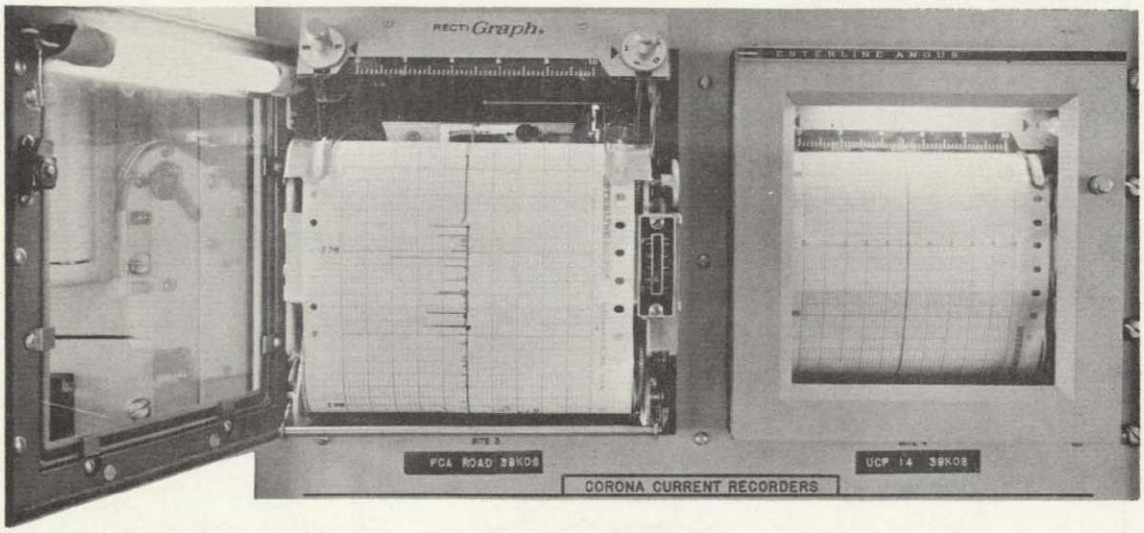

Figure 2-19. CC Recorders (left unit in servicing position)

The CC recorders use a pen-and-ink method of recording and selectable chart travel rates of 0.75, 1.5, 3, 6, or 12 inches per minute or hour are available via two control knobs located on the recorder chassis, accessible behind the recorder front cover. (Recording travel rate is set at 3 in./hour.) The chart rolls are time annotated and provide 4.5 in. for pen travel with the center (5) being the zero level; plus and minus CC information is recorded in divisions to the left and right of the center line, respectively.

2.5.4 CC Alarm Modules. The units assigned to detect CC flow at alarm levels are Esterline Angus-manufactured assemblies. The modules (figure 2-20) contain three identical, paralleled alarm circuits that actuate relays when a preset level of CC is reached on an applicable (site) recorder. Relay closure (alarm condition) provides ground circuit path completion for indicators as follows:

a. Lamp indication below the alarmed site module (1 through 8)

b. Lamp indication at the site location on the plotter board map

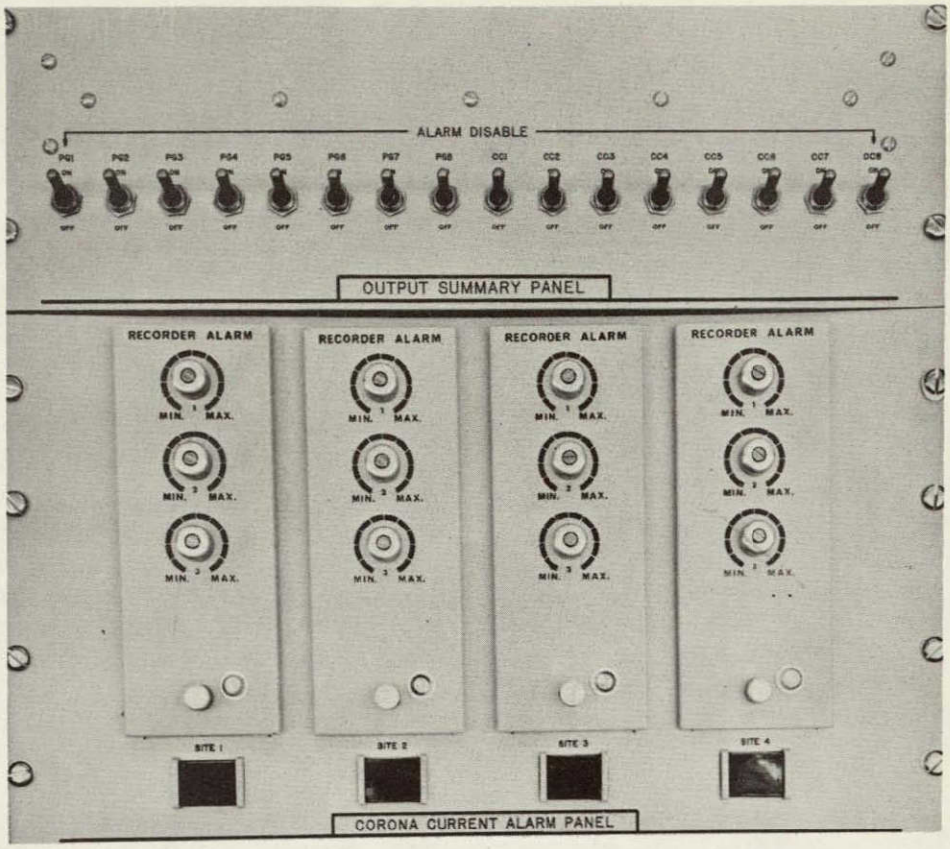

Figure 2-20. CC Alarm and Output Summary Panels

Present requirements call for alarm threshold settings to provide alarm indications at a CC flow of 3.0 μA. This requirement necessitates that operators set one of three adjustable alarm threshold controls of a module to activate the indicator relays with a known 3.0 μA of CC flow applied at the appropriate site whip antenna. The remaining two threshold controls have been deactivated.

2.6 INTERFACE PANELS

Three interface panels are installed at the MPC and one is installed at the LCC. The panels of the MPC are the Input TD (terminal distribution), Output Summary, and Patch Panels; the special panel at the LCC is a patch panel. The purposes of the panels are discussed in the following paragraphs.

2.6.1 MPC Terminal Distribution. This panel is the interface for all LWS information to the MPC. Hardline inputs from remote sites and sferics stations are distributed to units housed in the racks for recording or display purposes. The panel is located in the bottom portion of MPC Rack 4.

2.6.2 MPC Output Summary. The Output Summary panel (figure 2-20) contains 16 switches that allow operators to disable alarm circuits of PG and CC measurements. Since an alarm lamp mounted on the plotter board indicates an alarm condition of both PG and CC, the switch provides a method of determining which of the two measurements is responsible for alarm indications.

2.6.3 MPC Patch Panel. The Patch Panel (figure 2-13) provides for interface between meteorological and LWS sensors and MPC readout units. LWS operators at the MPC need only be concerned with Patchboard 3 (PB3) of the panel. PB3 is used to patch PG and CC measurements to the MPC recorders. [Inputs from remote sites (C.C. OUT and P.G. OUT) are wired to pairs of receptacles from the left (i.e., C.C. OUT receptacles A and B are the output of C.C. Site 1, etc.). MPC recorder input terminals are numbered in order from the left, are located in the center of PB3, and are labeled CC REC and PG REC, respectively.]

2.6.4 LCC Patch Panel. This patch panel is located in Rack 27 of the LCC. As in the case of the MPC patch panel, remote site outputs are wired to pairs of receptacles. The paralleled input is normally used for LWS information to Firing Rooms. Normal operations provide for a patchcord connection between the site input and an amplifier input, labeled Site (by number) and AMP IN, respectively. The amplifier output is patched to the MPC (AMP OUT to MPC IN, respectively). A Corona Current input from a site is patched directly to the MPC IN terminals.

SECTION III

OPERATING GUIDELINE

3.1 GENERAL

This section outlines procedures for setup and operation of LWS measurement units. Due to differences in site and central monitor configurations, the procedures have been divided so as to apply to common configurations. The procedures assume that site sensors and monitor units are functioning properly. If procedures fail to qualify a particular measurement, notify personnel responsible for repair and maintenance functions.

3.2 TURNON AND EMERGENCY TURNOFF PROCEDURES

Due to differences in rack configurations, procedures for turnon and emergency turnoff vary. Consult table 3-1 for familiarization with unit power control locations for individual unit turnon and turnoff functions. Perform applicable actions listed below

(1) Turnon procedure for LC-37 LWS,

a. Set Rack D41 circuit breaker (located at bottom of rack) to ON.

b. Set PG Master Control POWER control to ON.

(2) Turnon procedure for LCC LWS,

a Set PG Master Control POWER switches to ON.

b. Set PG Master Control RECORDER switches to ON.

c. Set CC Recorder power controls to HR

(3) Turnon procedure for MPC LWS,

a. Set Racks 2, 3, and 4 circuit breakers (located at bottom level of respective racks) to ON.

b. Set CC Recorder Power controls to HR

c. Set Rack 2 28V Power Supply power switch to ON.

d. Ensure that Output Summary Panel ALARM DISABLE switches are set to ON.

Table 3-1. Power Control Locations

Unit Name/Nomenclature	Control Name	Control Location
Recorder, Corona Current/Esterline Angus Series S	OFF/HR/MIN	Inside front access door, upper left corner of recorder mechanism.
Power Supply, 28Vdc	POWER ON	Upper-center of power supply.
Recorder, Potential Gradient/Rustrak Model 88	POWER	Pushbutton/indicator immediately below recorder.
PG Master Control Panel/SWE-1193	RECORDER ON/OFF	Knob below and to right of KV/M meter of SWE-1193-10 unit.
	POWER OFF/ON	Toggle switch below and to right of GRADIENT RATE OF CHANGE meter of SWE-1193-60 unit.
PG Master Control Unit/SWE-1193A	POWER ON	Toggle switch at bottom right of front panel.
	RECORDER ON	Toggle switch at right side of panel.
Sferics Receiver, Mark I/ARI Model SF-44	POWER ON/OFF/AUX	Switch at left center of receiver panel.
Sferics Oscilloscope/ HP 141A	POWER ON	Toggle switch at bottom left corner of scope.
Coordinate Position Resolver	none	Electrically interlocked to Milgo Plotter MASTER POWER pushbutton switch.
Sferics Sta 2 Demultiplexer	AC PWR OFF/ON	Toggle switch at bottom center of LSI Model 0683A Power Supply.
Milgo Plotter Console/ Model 4020A (modified)	MASTER POWER	Pushbutton switch at bottom left of center panel.

Table 3-1. Power Control Locations (Cont'd)

Unit Name/Nomenclature	Control Name	Control Location
Milgo Plotter Console/ Model 4020A (modified) (Cont'd)	DC POWER	Beside MASTER POWER pushbutton switch.
Sferics Sta. 2 Multiplexer	AC PWR OFF/ON	Toggle switch on bottom portion of power supply at right side of panel.
Keithley Micro-micro-ammeter/Model 410	POWER ON/OFF	Right-center near bottom of front panel beside METER polarity switch.

e. Depress PG recorder pushbuttons for POWER on indication.

f. Set PG Master Control panels POWER switches to ON.

g. Set PG Master Control panels RECORDER switches to ON

h. Set Demultiplexer panel Power Supply AC PWR switch to ON.

i. Depress Plotter Console MASTER POWER pushbutton for on condition.

j. Depress Plotter Console DC POWER pushbutton for on condition.

k. Place map on display area of Plotter Console, place magnets at corners of map, and depress VACUUM pushbutton for on condition.

(4) Turnon procedure for Sferics Station 2 LWS;

a. Set main power circuit breaker (located on North wall) to ON.

b. Set sferics Receiver POWER control to ON.

c Set Multiplexer Power Supply AC PWR switch to ON.

(5) Turnon procedure for LUT LWS;

a. Set Micro-microammeter POWER switch to ON.

For emergency turnoff of LWS units, first turn off circuit breakers, where applicable (MPC, Racks 2, 3, 4; LC-37, Rack D41; Sferics Station 2, wall mounted on North wall of shelter), then switch power controls of individual units to off condition. Reverse settings of 3.2.(3)b. through k., 3.2.(1)b.; 3.2.(4)b. and c. For LCC and LUT LWS emergency turnoff, reverse actions of 3.2.(2)a. through d. and 3.2.(5)a., respectively.

3.3 POTENTIAL GRADIENT AND CORONA CURRENT MEASUREMENTS

Eight PG and eight CC measurements are derived from the eight remote sites at KSC. In addition, CC measurements are made for special local (launch complex) purposes. Configuration of site installations vary, but procedures following are listed so as to provide for common configurations and checkout procedures. Refer to the appropriate procedure of following paragraphs for PG and CC maintenance, checkout, and operating procedure.

3.3.1 Scheduled Maintenance Procedures for PG and CC Sites. PG and CC measurement components are maintained on a scheduled basis. Checkout procedures are necessarily coupled with scheduled maintenance activities to ensure that the site equipment is operating properly. Site maintenance procedures are performed by field technicians at the measurement site while operators at readout stations verify test responses during checkout The following test components or their equivalents are needed by the field technician for field maintenance of PG and CC sites:

1. PG test fixture, PGC-1.
2. CC test fixture, BRM#2.
3. Test leads, alligator clips.
4. Field phone.
5. Soft-bristle brush or lint-free cloth
6 Container of freon.
7 Portable GN_2 bottle.

The procedures following are arranged in columns so as to place coincident actions of test personnel at the same level. Actions and notes applicable to all personnel cover the columns normally reserved for specific actions or notes. Common configurations are combined to simplify presentation

3.3.1.1 Site 1 PG Scheduled Maintenance and Checkout Procedure. Maintenance actions for Site 1 PG are scheduled two times weekly. The maintenance is performed to ensure a minimum of downtime for LWS measurements. The procedure involves actions on the part of a field technician (FLD TECH) at the site, a Blockhouse operator (BLHS OP) stationed at rack D41 of the blockhouse, and a Meteorological Prediction Center operator (MPC OP) stationed at the MPC LWS equipment racks. Each PG probe is checked at the laboratory to ensure that the instrument is usable, batteries contained inside the probe are charged or replaced, and new dessicant is placed in the probe. This action provides for an expected field life of three months. The FLD TECH should check a site Equipment History Log maintained at the MPC for possible probe rotation prior to performing the following maintenance actions. (A status log is also used to record scheduled maintenance performed and parameters read in checkout.) Figure 3-1 shows the configuration involved.

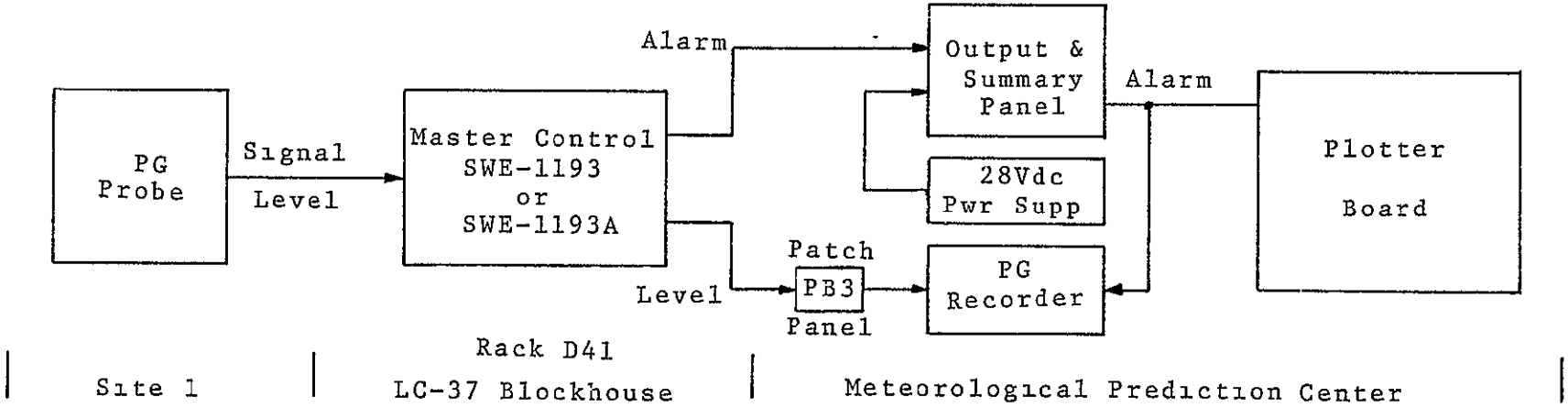

Figure 3-1. Configuration For PG Site 1

Proceed as follows:

FLD TECH	BLHS OP	MPC OP
a. Establish voice contact with checkout personnel and identify stations.		
b. Note general condition of probe, cabling, etc.	Standby for checkout.	Standby for checkout.
c. Check pressure of probe gauge and, if pressure is less than 2 psig, repressurize as follows; 1. Connect portable GN_2 bottle to inlet line of probe. 2. Open GN_2 bottle outlet valve and adjust pressure for 3 psig. 3. Open probe inlet valve. 4. When pressure gauge of probe indicates 3 psig, close probe inlet valve 5. Close portable GN_2 outlet valve. Uncouple bottle from probe.	Standby. NOTE In actions that follow, those actions preceded by (1) apply to SWE-1193 master control panels; those actions preceded by (2) apply to SWE-1193A master control panels.	Standby.

FLD TECH	BLHS OP	MPC OP
c. (Cont'd)	Standby.	Standby.
6. Check pressure at end of checkout for "no leak" verification. If pressure has dropped, replace probe. Record serial number of replacement.		
d. Perform preliminary site checkout as follows	Set alarm limit (red needle switches) to extreme POS and NEG positions offscale.	
1. Place PGC-1 test fixture atop probe cap using top set of cap holes as alignment & seating for fixture securing bolts. Notify operators that probe is in shielded condition.	Note and report reading of KV/M meter for shielded (zero) PG condition.	Record on status form the reading observed by BLHS OP. Note site recorder response. Ignore alarm indications.
2. Set PGC-1 power control to ON. Inform operators that positive voltages are to be applied to fixture. Set PGC-1 range switch to 5(kV/m), then 10, then 15.	Note KV/M meter readings of setting actions of FLD TECH.	Record readings observed by BLHS OP in step actions. Note and report recorder responses.

FLD TECH	BLHS OP	MPC OP
d. (Cont'd)		
3. Set PGC-1 power switch to OFF and reverse voltage leads from control unit to plexiglas anode and probe ground strap. Inform operators of polarity reversal.	Standby.	Standby.
4. Set PGC-1 power switch to ON and range selector to 5, then 10, then 15.	Note KV/M meter readout of step settings of FLD TECH.	Record readings observed by BLHS OP in step actions.
5. Set PGC-1 power switch to OFF. Remove test fixture from probe cap.		
e. Request PG turnoff.	Set PG master control power switch to off.	Standby.
f. Perform general cleanup actions of probe housing, cabling, stand, etc. Inspect probe cap area for entrapment of insects, rainwater, or other foreign materials. Check sensor for filmy appearance, indicating need for cleaning. If any of above conditions exist, clean sensor and cap as follows,	Standby.	Standby.

FLD TECH	BLHS OP	MPC OP
f. (Cont'd) 1. Using grease pencil, mark reference on probe cap and housing shell to ensure alignment in reinstallation of probe cap. 2. Loosen cap setscrews and unscrew cap. Count and record number of turns required for removal.	Standby.	Standby.
NOTE To preserve calibration parameters, it is imperative that cap be realigned to original position and depth after removal.		
3. Using brush or cloth specified and freon, clean probe sensor of any foreign matter, moisture, or corrosion. Exercise care to prevent damage to tritium foil sensor. Clean and dry interior of cap, but ensure that alignment marks are not erased.		

FLD TECH	BLHS OP	MPC OP
f. (Cont'd) 4. Using thread count and alignment marks made, replace probe cap to original position. Tighten set screws moderately so as not to damage housing screw threads.	Standby	Standby
g Check cabling for weather damage and ensure that connectors are tightly seated. Check probe ground strap for proper contact between housing and base terminal.	Standby	Standby
h. Position plexiglas hood on probe cap using top set of holes of probe cap. Connect positive lead of PGC-1 tester to cap fixture anode and negative lead to probe ground strap. Ensure that tester range selector is set to 0 (shorted) position. Request probe current turnon by BLHS OP.	Set PG master control panel power to on and proceed as necessary; (1) Verify that PROBE CURRENT meter reads 10 (SET). (If meter reads otherwise, adjust PROBE CURRENT control (below meter) to specified level. Check for electrical zero (0 level of KV/M meter). If electrical zero is not as specified, adjust ZERO ADJUST control. (If electrical zero is	Verify zero (center) response of site PG recorder. If meter does not read 0, verify with BLHS OP that master control panel meter (KV/M meter) is zeroed, then adjust recorder mechanical zero control (screwdrive adjustment in center of faceplate below viewing window) for 0 readout of recorder.

FLD TECH	BLHS OP	MPC OP
h (Cont'd)	beyond adjustment span, set ZERO ADJUST to mid-range and adjust COARSE ZERO potentiometer, located on back of chassis, to 0 level.) (2) Set GRADIENT SELECTOR control to PROBE (ATMOSPHERIC GRADIENT meter reading should appear at TEST level of meter scale.) If meter does not read at TEST, slide unit from rack mounting for access to PROBE CURRENT SET adjustment and adjust for TEST level. Switch GRADIENT SELECTOR to 15KV/M position and check ATMOSPHERIC GRADIENT meter for electrical zero (0) reading. If necessary, adjust main chassis 15KV/M ZERO control for specified zero reading.	

FLD TECH	BLHS OP	MPC OP
h (Cont'd)	NOTE The PG recorder located on the Master Control Panel is not operational at LC-37 Blockhouse.	
i. Notify operators that first test setting will be 15kV/m and set PGC-1 power switch to ON and range selector to 15.	(1) Check for POS 15 ±0.75 kV/m response of meter. Notify FLD TECH of response noted. (2) Check for POS 15kV/m (±2½ divisions) response of meter and notify FLD TECH of response noted.	Check site recorder response for same level as noted by BLHS OP.
j. Switch PGC-1 range selector to 0, reverse test leads to probe cap fixture, and switch range selector to 15. Notify operators that -15kV/m is applied.	(1) Check for NEG 15 ±0.75 kV/m response of meter and notify FLD TECH of response noted. (2) Check for NEG 15kV/m (±2½ divisions) response of meter and notify FLD TECH of response noted.	Check response of site recorder for reading noted by BLHS OP.

NOTE

If readout of ±15kV/m were beyond tolerance specified in previous steps, corrective action is necessary in the setting of probe cap depth for linearity and/or setting of slider aperture for voltage level. Common responses are slightly higher than nominal for

FLD TECH	BLHS OP	MPC OP
for negative PG readings, slightly lower than nominal for positive PG readings. Adjust probe cap to point where readout responses are the same amount of voltage above and/or below a nominal point. Once this linearity has been achieved, the cap slider aperture may be adjusted for increased or decreased level.		
k. Note readings reported by BLHS OP in steps h. and i., set PGC-1 power switch to OFF, remove plexiglas fixture, loosen probe cap setscrews (ensure that probe cap rotates freely), replace fixture, set PGC-1 power switch to ON, and adjust cap downward if readings were below nominal, upward if above. Achieve linearity as described in Note above when repeating steps i. and j. actions.	Keep FLD TECH and MPC OP posted as to master control meter responses for ±15 kV/m actions of FLD TECH.	Verify recorder responses for readings noted by BLHS OP.
CAUTION Do not use plexiglas fixture as handle when adjusting cap. A sticking action of probe cap could result in damage to fixture if excessive physical pressure is applied.		
NOTE Do not adjust probe cap far		

FLD TECH	BLHS OP	MPC OP
k. (Cont'd) enough downward to make contact with sensor mounting. Use cap slider aperture adjustment after it is noted that three-or-less screw-threads remain for cap travel in downward direction.		
l. If readout level is needed, set PGC-1 power control to OFF and remove plexiglas fixture for access to cap slider lock-screw. Adjust slider (increase aperture for higher level of readout; decrease aperture for lower level of readout) relock, replace test test fixture and recheck for ±15kV/m. Readjust probe cap for linearity, if necessary.	Keep FLD TECH and MPC OP posted as to master control meter responses for ±15kV/m level actions of FLD TECH.	Verify recorder responses for readings noted by BLHS OP.
m. With test fixture in place and PGC-1 range selector set to 0, request BLHS OP to reset readout zero, if necessary.	Inform FLD TECH of zero response of readout unit and rezero unit as directed in step g.	See step g. action.

FLD TECH	BLHS OP	MPC OP
Repeat steps h. through l. until responses for ±15kV/m are as specified in steps. The zero response for SWE-1193 units is 0 ±0.75kV/m after ±15kV/m have fallen within specified limits. The SWE-1193A unit should be set precisely to 0 with ±15kV/m responses falling within limits specified. NOTE If above actions do not result in specified responses, the Blockhouse operator should slide readout far enough out of rack for access to SWE-1196-10 chassis CAL control (SWE-1193) or SWE-1193A 15KV/M CAL (main chassis) control. Make slight adjustments of appropriate CAL control while ±15kV/m and zero actions are repeated. (If combined actions performed above do not result in specified readout responses, notify site representative for corrective action.)		
n. When linearity and level have been achieved, remove PGC-1 fixture and ensure that setscrews and slider lockscrew of probe cap are secure. Replace test fixture and recheck ±15kV/m and zero levels.	Record meter readout of 0 and ±15kV/m actions	Verify recorder responses for 0 and ±15kV/m actions.
o. Request verification for ±5kV/m and ±10kV/m readouts. Set PGC-1 range selector to 5, then 10. Set PGC-1 range selector to 0 (SHORT), reverse leads to test fixture, and apply -5kV/m and -10kV/m.	Verify and record ±5 and ±10 kV/m reading of master control panel meter.	Verify site recorder responses for ±5 and ±10kV/m.

FLD TECH	BLHS OP	MPC OP
p. Set PGC-1 range selector to 0 and request confirmation of alarm functions. After BLHS OP has confirmed that alarm limit switches have been set, set range selector to 5, return range selector to 0, reverse leads, and set RANGE selector to 5.	(1) Set POS and NEG alarm limit needles to + and - 2.4kV/m, switch ALARM HORN to ON, and verify alarm condition when FLD TECH applies ±5kV/m. When alarm horn sounds, switch ALARM HORN switch to OFF and wait for verification by MPC OP before depressing ALARM RESET pushbutton. (2) Set POS and NEG alarm switches to + and - 2.4kV/m. Set BUZZER switch to ON. When buzzer sounds, switch to OFF (automatic reset circuit will reset master control panel.) Repeat BUZZER switch action for opposite polarity alarm condition.	Check for alarm condition response of ALARM indicator beneath site PG recorder. Note also that red lamp lights at site location on plotter board. Switch appropriate PG toggle of Output Summary panel to OFF, check to see that both alarm indicators go out, return PG toggle to ON, and verify that MPC PG alarm circuits are operational. (Alarm lamps will go off when BLHS OP resets control panel alarm circuits.) Repeat above actions when opposite polarity alarm condition occurs. Annotate recorder chart roll as required.
q. Set PGC-1 range selector to 0 and power switch to OFF. Wait for confirmation by BLHS OP of step actions, then remove test fixture from atop probe cap and apply RTV-1 sealer to probe cap setscrews and slider cap locking screw.	(1) Note response of KV/M meter zero with probe shielded by FLD TECH action of this step. Replace metallic TEST VOLTAGE tab above meter with one listing new zero response level. Readjust alarm switch	Standby.

FLD TECH	BLHS OP	MPC OP
q. (Cont'd)	needles for nominal 2.4kV/m above new TEST VOLTAGE notation. (2) Slide chassis from equipment rack, place NORM/CAL slider switch to CAL, set GRADIENT SELECTOR to CALIB., and adjust main chassis CAL SET control for TEST response of meter. Switch GRADIENT SELECTOR to 15KV/M, return slider switch to NORM, and return unit to rack position, secured.	Standby.
r. Standby.	(1) Ensure that SWE-1193 Master Control Panel settings are as follows; 1. Power switch (left module) is ON. 2. RECORDER control is OFF (Site 1 only). 3. ALARM HORN is OFF (Site 1 only). (2) Ensure that SWE-1193A Master Control Panel settings are as follows, 1. POWER switch is ON.	Standby.

FLD TECH	BLHS OP	MPC OP
r. (Cont'd)	2. RECORDER switch is OFF (Site 1 only). 3. BUZZER switch is OFF (Site 1 only). 4. GRADIENT SELECTOR is at 15KV/M.	Standby.
s. Inform MPC OP of general appearance of site upon arrival, any corrective actions taken, and serial number of PG probe.	Inform MPC OP of readings recorded previously for kV/m readouts.	Record information furnished by FLD TECH and BLHS OP on measurement status report.

3.3.1.2 Site 1 CC Scheduled Maintenance and Checkout Procedure. Maintenance actions for Site 1 CC are performed coincident with PG maintenance actions. Since the LC-37 Blockhouse is bypassed, only two personnel are needed to complete the site CC measurement qualification. These will consist of field technician (FLD TECH) stationed at the site sensor and a MPC operator (MPC OP) stationed at the equipment racks of the MPC. A battery pack/amplifier assembly located at the site is periodically checked by the laboratory to ensure that the assembly is operational, that the batteries are fully charged, and that the amplifier module is capable of balance and gain specifications required. Figure 3-2 shows the measurement configuration.

Proceed as follows.

FLD TECH	MPC OP
a. Establish voice contact with MPC OP and identify station.	Verify voice contact with FLD TECH.
b. Inspect whip antenna, battery pack, and cabling for weather damage. Remove	Standby.

FLD TECH	MPC OP
b. (Cont'd) cover from battery pack/amplifier assembly.	Standby.

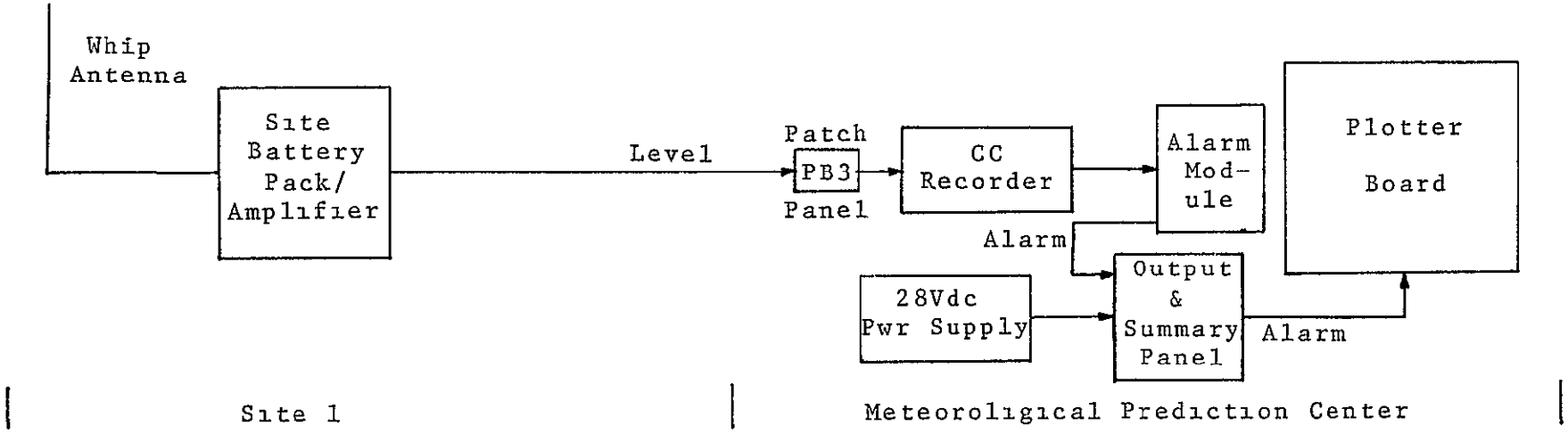

Figure 3-2. Configuration For CC Site 1

c. Place test lead (short) between antenna and coaxial leadin shield (ground).	Adjust recorder for zero CC (center response of site CC recorder). (See para. 3.3.3.2 zero instructions steps b.2. through b.4.
d. Remove test lead short from antenna.	Standby.

FLD TECH	MPC OP
e. Remove battery pack output jack and connect BRM#2 test fixture plug to output connector of battery pack. If test fixture meter reads less than 30.0Vdc, replace battery pack/amplifier assembly.	Standby.
f. Remove test fixture plug from battery pack connector and reconnect output cable.	Standby.
g. Connect positive lead of BRM#2 test fixture to whip antenna and negative lead to cable shield (ground). Place fixture power switch to ON and adjust potentiometer for 1.0Vdc reading of meter.	Observe +10±0.1μA (1 level of recorder scaleplate) response of site recorder. If reading is not as specified, request *FLD TECH adjustment of amplifier GAIN control.*
h. Adjust amplifier GAIN control, if necessary.	Verify GAIN setting action of FLD TECH.
i. Reverse test leads to whip antenna and ground. Ensure that meter reads 1.0Vdc.	Observe -10±0.1μA (9 level of recorder scaleplate) response of site recorder. If reading is correct, record on measurement status log the readings of this step and step g.

NOTE

If recorder response is not ±10±0.1μA in step i., an unbalanced amplifier is indicated. Replace battery pack/amplifier assembly and repeat checkout.

FLD TECH	MPC OP
j. Decrease BRM#2 output to 0.3Vdc.	Ensure that site alarm module controls 1, 2, and 3 are set fully ccw. Slowly adjust control 1 cw until alarm lamps of alarm module and site location beneath plotting map light. Check disabling action of site CC alarm switch of the output summary panel.
k. Set BRM#2 power switch to OFF and remove test leads from across whip antenna. Replace battery pack cover.	Verify control settings as follows; 1. CC Recorder speed controls to MIN and 3, chart time as applicable. 2. CC Alarm Disable switch to ON (allowing display of possible CC alarm condition).

3.3.1.3 Sites 2 & 3 PG Scheduled Maintenance and Checkout Procedure. Figure 3-3 shows the configuration for PG Sites 2 and 3. The sites are connected to the MPC directly via longlines. Two PG master control panels provide power control and monitor capability. The master control recorders are used for recording purposes with no remote readouts provided. This configuration integrates the functions of direct and remote monitoring used in the Site 1 configuration. Therefore, the procedure listed in paragraph 3.3.1.1 will be used for Site 2 and 3, but the actions listed for the BLHS OP and MPC OP must both be performed by the MPC OP. The PG recorder operated by the MPC OP is contained in the master control unit instead of Rack 3.

3.3.1.4 Sites 2 & 3 CC Scheduled Maintenance and Checkout Procedure. The configuration shown in figure 3-2 is identical to the one for Sites 2 and 3. The procedure listed in paragraph 3.3.1.2 will be used for the sites scheduled maintenance and checkout.

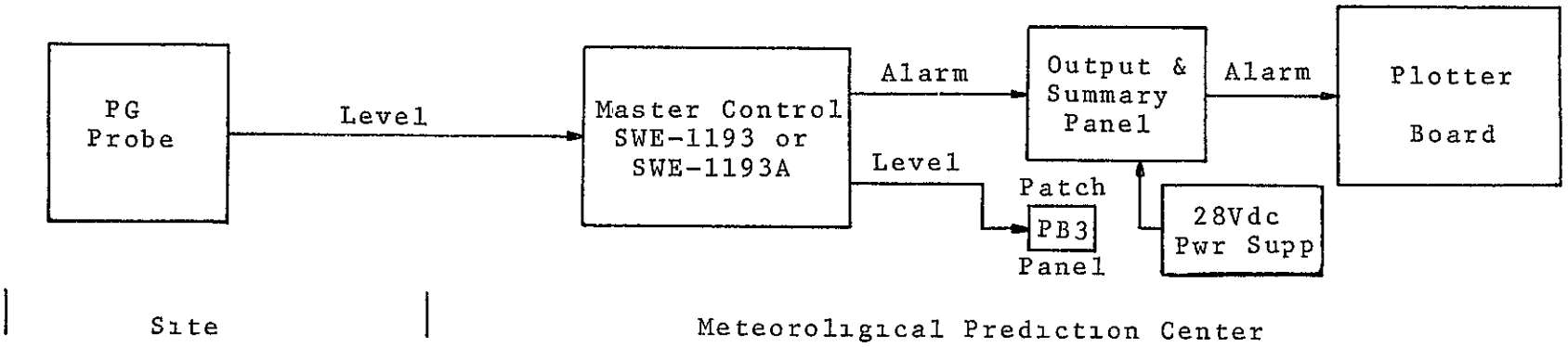

Figure 3-3. Configuration For PG Sites 2 and 3

3.3.1.5 Sites 4 through 8 PG Schedule Maintenance and Checkout Procedure. PG Sites 4 through 8 are identical in configuration (see figure 3-4). Master control units for the measurements are housed in equipment racks at the LCC, remote recorders are housed in racks of the MPC.

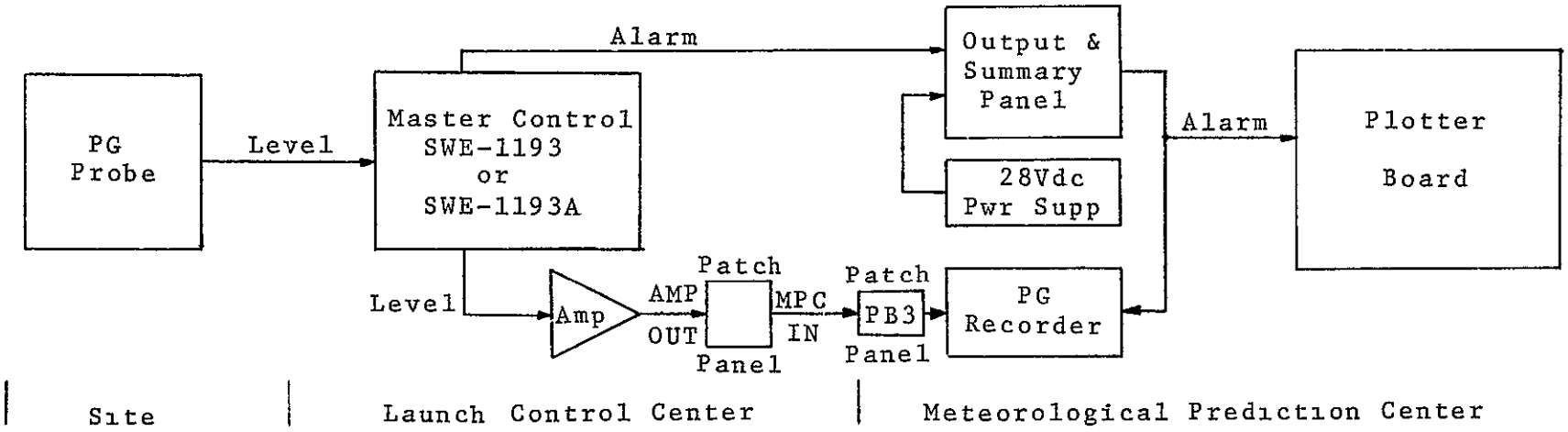

Figure 3-4. Configuration For PG Sites 4 through 8

Proceed as follows.

FLD TECH	LCC OP	MPC OP
a. Establish voice contact with other checkout personnel and identify stations.		
b. Perform steps a. through d. 1. of paragraph 3.3.1.1.	See paragraph 3.3.1.1 for actions of BLHS and MPC for master control and recorder units. When FLD TECH notifies other checkout personnel that probe is in shielded condition, adjust recorder for midscale (0) response.	Unpatch site PG input to recorder and place shorting plug in recorder input jacks. Adjust screwdriver adjustment below recorder window for +15kV/m response of recorder. Repatch site input to recorder.
c. Standby.	Move POS alarm switch to make contact with KV/M meter needle, then adjust POS alarm switch so as to bring KV/M meter needle to +15kV/m level. Notify MPC OP of action.	Check for +15kV/m response of site recorder. If response is other than specified, request LCC OP setting action of site PG line amplifier.
d. Standby.	Adjust site PG line amplifier ZERO control for +15kV/m response of MPC site recorder.	Verify proper setting of site PG line amplifier by LCC OP.
e. Standby.	(1) Depress ALARM RESET for return to normal operation. (2) Repeat step c., when necessary, to maintain meter reading of +15 kV/m if automatic reset action occurs during step action. Return POS alarm switch to	

FLD TECH	LCC OP	MPC OP
e. (Cont'd)	offscale position.	
f. Starting with step d. 2. of paragraph 3.3.1.1 perform remaining steps of procedure. Repeat steps b. through e. (above) when making zeroing adjustments in procedure.		

3.3.1.6 Sites 4 through 8 CC Scheduled Maintenance and Checkout Procedure. The configuration for CC Sites 4 through 8 provides a remote recorder capability to the LCC (figure 3-5). The recorders used at the LCC are identical to those of the MPC. In maintenance and checkout of CC Sites 4 through 8, the added operator actions (LCC OP) will duplicate those of the MPC operator (MPC OP) in procedures of paragraph 3 3.1.2 except that references to alarm-setting actions will not be performed by the LCC OP. The actions performed by the field technician (FLD TECH) and MPC OP remain applicable.

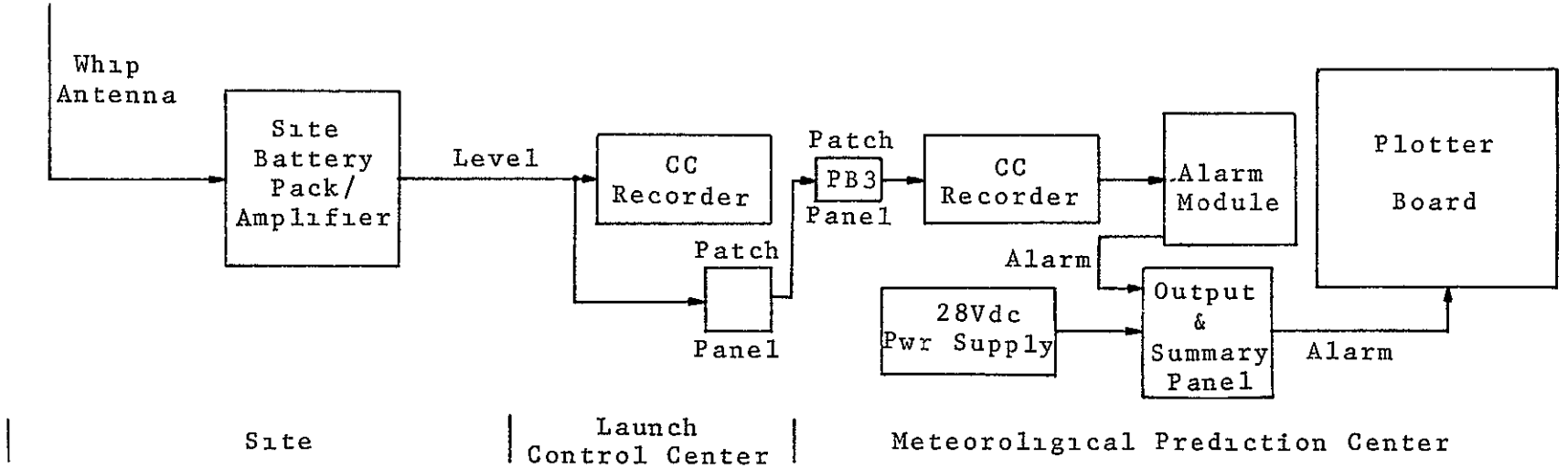

Figure 3-5. Configuration For CC Sites 4 through 8

3.3.1.7 LUT Installation CC Checkout. Corona Current measurements taken at launch complexes for launch support operations are included in programmed measurements. The CC units

involved are as follows

a. 1 CC whip antenna
b. 1 CC μμA readout (Keithley 410)
c. 1 CC recorder (E-A Series S)
d. 1 CC alarm module (E-A)

Operating procedures for the LUT CC configuration are covered in IN-MSD document PC-GEO-3 PROC-003.

3.3.2 Unscheduled PG and CC Maintenance Procedures. Unscheduled maintenance procedures are performed when units of PG and CC measurement configurations are suspected of faulty operation or fail to provide measurement information. In such cases, proceed as follows

FLD TECH	MPC OP or LCC OP
a. Potential Gradient 1. Perform applicable scheduled checkout of prior paragraph. If unit fails checkout, proceed.	
2. Perform steps 9.1.3 through 9.1.7 of vendor O&M manual. 3. Perform steps 9.2.1 through 9.2.3 and 9.2.5 and 9.2.6 of vendor O&M manual. 4. Perform end-to-end continuity check between probe and master control unit.	Standby for necessary actions to implement checkout of system.
NOTE It will be found that the probe batteries and weather conditions will be the prime reason for failure. During or after a heavy rainfall the KV/M meter may stay at zero, indicating a probe short due to entrapment of rainwater and requiring probe cleaning actions.	

FLD TECH	MPC OP or LCC OP
b. Corona Current 1. Perform applicable scheduled checkout of prior paragraph. If unit fails checkout, proceed.	
2. Perform a visual check of antenna, cables, and antenna insulator. Replace, if necessary. NOTE If battery pack is removed, note serial number of battery pack installed, and return removed battery pack to Trailer 299 for recharging.	Unpatch input signal to recorder Using jumper cables, hook-up output of a DC power supply to the input of the recorder and set to 1.0Vdc. Verify ±10μA recorder responses to the known input voltage of both polarities. NOTE If above steps show recorder to be operating properly, perform end-to-end continuity check of hardlines from site. If hardline continuity check proves satisfactory, request battery pack/amplifier replacement. If recorder trace starts to drift or appears noisy (spikes) the indication is that battery pack needs charging. If this condition exists, a field technician will be dispatched to the site as soon as possible.

3.3.3 PG and CC Recorder Servicing. The paragraphs that follow outline procedures to be performed at times that checkout procedures are not being performed and immediately prior to checkout. It should be noted that calibration of PG and CC recorders are performed at a calibration laboratory. Steps listed below are operator functions and such personnel should refrain from making adjustments that may destroy calibration integrity.

3.3.3.1 Potential Gradient Recorders. The PG recorders are located in MPC Rack 3 and in PG Master Control Panels. The recorders are preset to operate at a one-inch-per-hour chart speed. Drive mechanism may not always provide linear operation to coincide with time gradients of the recorder paper rolls. Therefore, periodic annotation by operators must be made to ensure that correct times are entered. This is particularly true of maintenance operations, checkout operations, and when alarm conditions are experienced. Note time and date in each case. To reload the recorder, proceed as follows·

a. Loosen retaining thumbscrew at top-left of recorder and allow front cover and recorder mechanism to come forward and down until it rests on hinge stop.

b. Set release clips on either side of takeup roll so that recorder roll may be removed.

c. Observe threading path instructions located on left-inside wall of recorder, re-load recorder with appropriate time-annotated chart roll to coincide with preset speed of drive mechanism.

d Return release clips in position to retain supply and takeup rolls

e. Depress control located on left side of drive mechanism and rotate takeup roll until proper chart time appears at bottom of display window adjacent to marking stylus

f. Annotate chart roll.

g. Return recorder mechanism to operating position (close front cover) and tighten retaining thumbscrew.

3.3.3.2 Corona Current Recorders. The CC recorders are located at LCC, LC-37, and MPC. Operators set conditions for operating

speed of recorders (at present, 3 inches/hour) via controls located at the top of the recorder mechanism at either side. The backlighted access door must be opened for access to controls and to place a recorder in the servicing position. To do so, unscrew the access door retaining thumbscrew, open door fully, grasp horizontal bar located across the bottom of the recorder and pull forward until lock mechanism prevents recorder movement. To return the recorder to operating condition, depress lock mechanism located at right bottom of recorder, push recorder back into case fully, and close and lock access door.

a. To ink the pen, proceed as follows

1. Rest pen element on a flat surface and pierce the top of ink cartridge with capillary tube. With holder prongs gripping the cartridge sides, insert tube until holder is flush with top of the cartridge.

2. Hold cartridge assembly so that pen is suspended by flexible hose, permit pen to swing freely until all twists in hose are removed. Free position of pen staff must be parallel with cartridge holder.

3. Seat knife-edge pivot of pen firmly between movement-fork assembly Insert cartridge bayonets into top of slots in support assembly and permit cartridge assembly to drop into operating position

4. See that cartridge holder is all the way down in the bracket slots Cover hole in primer bulb, compress bulb, uncover hole, and release. Repeat this process until ink appears at pen point

b. To zero recorder, proceed as follows·

1. Make sure no signal is applied to input terminals and that pen is full of ink and correctly balanced If common return of input circuit is above ground potential, disconnect the input completely.

2. Open panelgraph door, pull chassis out to service position, and raise scaleplate assembly.

3. Locate round black knob at base of movement beneath front portion on chassis

4. Turn zero knob until pen point comes to rest exactly on zero line of chart. (If pen travel appears jerky in this action, ensure that pen slides are clean)

NOTE

The zero setting of the pen element must be checked periodically to assure accurate recording. Recording errors may be introduced if zero is shifted to a position other than that for which the instrument is designed.

c. To install chart paper roll, proceed as follows:

1. Check to see if chart paper has appropriate time marking.

2. Open the case door and check that chart-drive power is OFF.

3. De-energize measuring element(s).

4. Press down on latch in lower right corner of chart transport assembly and pull chassis out to the service position.

5. Press down on right and left reroll latches near bottom of chart transport and remove reroll cylinder Do not remove gear plug from end of cylinder.

6. Raise scaleplate until it latches in position. Lift small lever knob on right side of transport and permit assembly to tilt down.

7. Remove supply roll arbor by pushing back and lifting straight up Center paper roll on arbor (elongated perforations to right) and snap loaded arbor back into transport

8. Tear or cut end of paper to "V" shape, turn up point slightly and feed under hold-down bar and over top of drive roller. Turn time-set knob so roller pins engage chart perforations.

9. Swing transport up to operating position Holding cylinder with gear end to right, insert chart into slot, and slide paper-guide disk on gear end of cylinder outward. Roll several turns onto the cylinder and slide guide disk inward, just to edge of paper

10. Snap reroll cylinder back into transport Take up chart slack by rotating disk on left end of reroll cylinder.

11. Rotate the panel knobs in either direction to select the desired feed rate.

12. Lower scaleplate, turn on chart drive, and check operation.

NOTE

Steps (13) through (15) are for a chart drive incorporating a multispeed transmission electric shift.

13. Place knob on left in desired time-rate position

14. Set right knob to desired transmission speed.

15. Stop chart paper by rotating switch on left to OFF position.

NOTE

To speed up the reroll action without throwing the chart out of time, manually rotate the left-hand disk on the reroll cylinder If a large portion of the chart must be rerolled, the cylinder should be removed and the chart rerolled by hand

d. To remove rerolled chart, proceed as follows.

1. Turn off chart-drive and pull chassis out to service position.

2. Press down on side latches and remove reroll cylinder and chart.

3. Remove gear plug from right end of reroll cylinder.

4. Slide chart roll from open end of cylinder. If chart is too tightly wound, carefully twist paper roll counter-clockwise as it is being withdrawn from cylinder. Place gear plug back into end of cylinder, making sure that the small key pin on the plug engages slot in cylinder.

3.3.4 PG and CC Logbook and Recorder Chart Annotation. The following logbooks and records are maintained at the MPC for correlation of PG and CC measurements and equipment status.

a. MPC Measurement Program Status - a status report filed daily outlining whether downtime was experienced by a measurement.

b. PG and CC Measurement Status - a status report filed after maintenance and checkout performance outlining parameters measured. (This status sheet verifies that sites are maintained on a scheduled basis.)

c. PG Equipment Log - a logbook listing current serial numbers of units installed for PG measurements.

d. CC Equipment Log - a logbook listing current serial numbers of units installed for CC measurements.

e. MPC to LCC Verification of Sites 4 through 8 - listing of readouts of MPC recorders to those of the LCC at time of scheduled maintenance.

PG and CC recorder strip charts are annotated as follows:

a. At the beginning of each shift that measurements are being monitored by station operators.

b. When it becomes necessary to advance chart time to agree with real time.

c. After performance of scheduled maintenance and checkout.

d. Sudden increases of level resulting from near strikes (verified by second person, if possible).

e. Downtime necessitating unscheduled maintenance.

3.4 SFERICS SETUP AND OPERATION

Procedures outlined on the pages that follow provide for setup and checkout of individual units associated with the overall plotting of sferics. The final procedure outlines an integrated procedure for plotting sferics. The setup of the Station 2 transmitter and MPC receiver (demultiplexer) is scheduled for once every two weeks. The remaining actions are daily routines or are performed when indications show that a storm is approaching plotting limits of the system. No arbitrary procedure should be attempted until reviewed by IN-MSD for validity. Conditions may exist that will require some experimentation. This is particularly true at times when several thunderstorms may be observed. Therefore, operations directives will be issued to supplement this procedure. In all cases such directives shall have precedence.

3.4.1 Sferics Setup and Checkout Procedures. Setup of sferics units located at the MPC involves actions by the normal duty operator. The setup of MPC units is performed at the beginning of each shift that the system is being monitored. The setup of Sferics Station 1 involves turnon or verification of control settings for the receiver, oscilloscope, and associated differential amplifiers. Sferics Station 2 consists of a model SF-44 receiver (connected to loop and sense antennas via coaxial lines) the outputs of which are fed to a transition panel containing divider circuits and then to the transmitter system. The transmitter consists of 3 VCO's which are used to frequency modulate sferics information fed to time delay networks and frequency translators. Outputs of the latter two types of modules are sent to a summing amplifier and output transformer for application to the A2A transmission system. Receiver units at the MPC receive the sferics information from the transmission system and detranslate the FM signals, apply the information to discriminator units for restoration to analog levels and to inverters for interface. The inverted signals are then applied to deflection and unblanking circuits to the Sferics Station 2 Oscilloscope for display of coordinates. The Station 2 setup procedure requires actions of technicians at the station and at the MPC. Necessary voice communication between the two may be by black phone or by field phone.

The following test units or their equivalents are needed by the station technician for sferics setup.

Signal Generator, HP Model 651 A

Oscilloscope, Textronix Model 453 with P6010 probe

DC Voltmeter, HP Model 3430A

AC Voltmeter, HP Model 400E

Frequency Counter, HP 5246L

Equipment needed by the MPC technician for setup consists of,

Oscilloscope, Textronix Model 453 with P6010 probe

DC Voltmeter, HP Model 3430A

AC Voltmeter, HP 400E

3.4.1.1 Sferics Station 1 Receiver Setup. Proceed as follows:

Procedure	Action/Indication/Function
a. Verify that POWER switch is on	1. PWR indicator is lit.
b. Verify WHIP AMPL is NOR	
c. Set GAIN switch to position to observe sferics (sudden increases in PEAK FIELD STRENGTH meter). Ensure that GAIN setting is such that sudden increases in meter resulting from sferics action do not exceed midrange deflection of meter	1. Sferics activity will be noted as sudden increases in meter reading followed by slow (dampened) decreases.

3.4.1.2 Display Oscilloscopes Setup. Proceed as follows:

Procedure	Action/Indication/Function
a. Verify that power switch is on	
b. Adjust FOCUS and INTENSITY as required to observe clear traces	1. Dot in center of scope face should be just barely visible.
c. Place PERSISTENCE control at midrange	

Procedure	Action/Indication/Function
d. Set WRITING RATE switch to NORMAL	
e. Set writing function switch to WRITE	1. Sferics activity will be noted as sudden streaks displays on face of scope. The direction of trace from center points to coordinate (degrees) of strike with respect to site.

3.4.1.3 Differential Amplifiers Setup. Proceed as follows:

Procedure	Action/Indication/Function
a. Ensure BANDWIDTH switches (KC) are at 40	
b. Ensure AMPLIFIER switches are at AC	
c. Set +INPUT switches to OFF	
d. Set -INPUT switches to AC	
e. Set SENSITIVITY controls for display of dot on oscilloscope face	1. Display of dot should be seen on oscilloscope face.
f. Center dot at center of scope face by adjusting POSITION controls	1. Initial balancing position.
g. Adjust DC BALANCE controls for center display of dot	1. Balance of position to provide center display of sferics without necessity of adjusting POSITION

Procedure	Action/Indication/Function
g. (Cont'd) on oscilloscope as SENSITIVITY controls are changed from one range to another	1. (Cont'd) controls of oscilloscope when amplifier SENSITIVITY controls are changed in range.

3.4.1.4 Sta. 1 Differential Amplifier-Sferics Receiver Unblanking Verification. Proceed as follows

Procedure	Action/Indication/Function
a. Set receiver GAIN switch to 0	
b. Set receiver WHIP AMPL switch to OUT	
c. Position dot at center of oscilloscope with scope POSITION controls	
d. Alternately switch receiver GAIN to 10, then 0	1. Trace should appear at either 45- or 225- degree points of scope. If no trace is apparent, proceed to step e.
e. Decrease SENSITIVITY switches of differential amplifiers until alternate changes of receiver GAIN switch produces traces at 45- and 225-	1. (See previous step action.)

Procedure	Action/Indication/Function
e. (Cont'd) degree points of scope	NOTE Sferics Sta. 2 may be verified in the same manner, but an operator at the station must perform the receiver GAIN and WHIP AMPL switch functions.

3.4.1.5 Plotter Board Setup. Proceed as follows:

Procedure	Action/Indication/Function
a. Depress MASTER POWER, STANDBY and UP push-buttons	1. MASTER POWER indicator lights, and 2. STANDBY and UP indicators do not light, but push-buttons are mechanically interlocked with OPERATE and DOWN pushbuttons to ensure that these functions are disabled when step b. is performed.
b. Depress DC POWER push-button	1. DC POWER indicator lights, and 2. Pen arm positions pen in standby position (center, right margin).
c. Place map on display area to coincide with range of plot to be made. Use T-square for border/map bed lineup	1. Actions c. through e. are required for initial turnon or when changing maps.

Procedure	Action/Indication/Function
d. Place 4 small magnets at corners of map	1. To hold map in place if vacuum system fails.
e. Depress VACUUM pushbutton	1. VACUUM indicator lights, and 2. Vacuum motor starts pumping action.
f. Open bottom console access doors, depress the switch of each DC amplifier, and, if indicator of depressed switch row lights, adjust potentiometer control of switch row until lamp goes out	1. Amplifier balancing.
g. Depress ORIGIN pushbutton	1. ORIGIN indicator lights.
h. Depress OPERATE pushbutton	1. OPERATE indicator goes on, 2. STANDBY indicator goes out, and 3. Arm travels to position pen above center (Origin) point of map. NOTE If map is placed on display area improperly, origin point will be off and map must be repositioned to ensure that ORIGIN point is centered beneath the pen.

Procedure	Action/Indication/Function
i. Depress UPPER/LOWER pushbutton	1. Pen corresponding to lighted indicator shifts of position above origin point.
j. Depress DOWN pushbutton	1. Pen places mark at ORIGIN point.
k. Repeat steps i. and j.	1. To check shift to second pen, and 2. To check "down" action of second pen.
l. Depress UP pushbutton	1. Pen returns to UP position.
m. Return to standby (depress STANDBY pushbutton	1. STANDBY indicator lights, 2. OPERATE indicator goes out, and 3. Arm travels to place pen at center of right margin of map.
n. Re-depress ORIGIN pushbutton	1. ORIGIN lamp goes out.
o. Depress PX ADJUST pushbutton	1. PX ADJUST indicator lights.
p. Depress OPERATE pushbutton	1. OPERATE indicator lights, and 2. Arm travels to position pen at or near SF#1 point of map. NOTE If pen does not rest at the SF#1 point, unlock and adjust the PARALLAX heliopots to bring pen to the SF#1 point. Relock heliopots when

Procedure	Action/Indication/Function
	NOTE (Cont'd) action is completed.
q. Return to standby	1. See m. 1, 2, 3, above.
r. Re-depress PX ADJUST pushbutton	1. PX ADJUST goes out.
s. Depress SCALE pushbutton to correspond to map range	1. Selected SCALE indicator lights.
t. Hold DISTANCE ADJ pushbutton down and depress OPERATE pushbutton	1. DISTANCE ADJ indicator lights, 2. STANDBY indicator goes out, 3. OPERATE indicator lights, and 4. Arm travels to position pen at or near the SF#2 point on map. NOTE If pen position is not above the SF#2 point, adjust DISTANCE SCALE screwdriver adjustment until pen is in proper position.
u. Release DISTANCE ADJ pushbutton and return to standby (m. above)	1. See m. 1, 2, 3, above.

3.4.1.6 Sferics Station 2 Transmitter Setup. The following procedure covers actions required for setup of the sferics transmitter system housed in equipment racks of Sferics Station 2 portable equipment shelter. This procedure requires actions by a technician equipped as specified in paragraph 3.4.1. The MPC operator (MPC OP) remains on a standby status while this procedure is being performed. Upon completion of this procedure, the field technician goes to a standby status while the MPC OP sets up the receiver portion, the final procedure (para. 3.4.1.8) requires subsequent actions on the part of the field technician. Figure 3-6 shows the configuration involved in this and the following two setup procedures.

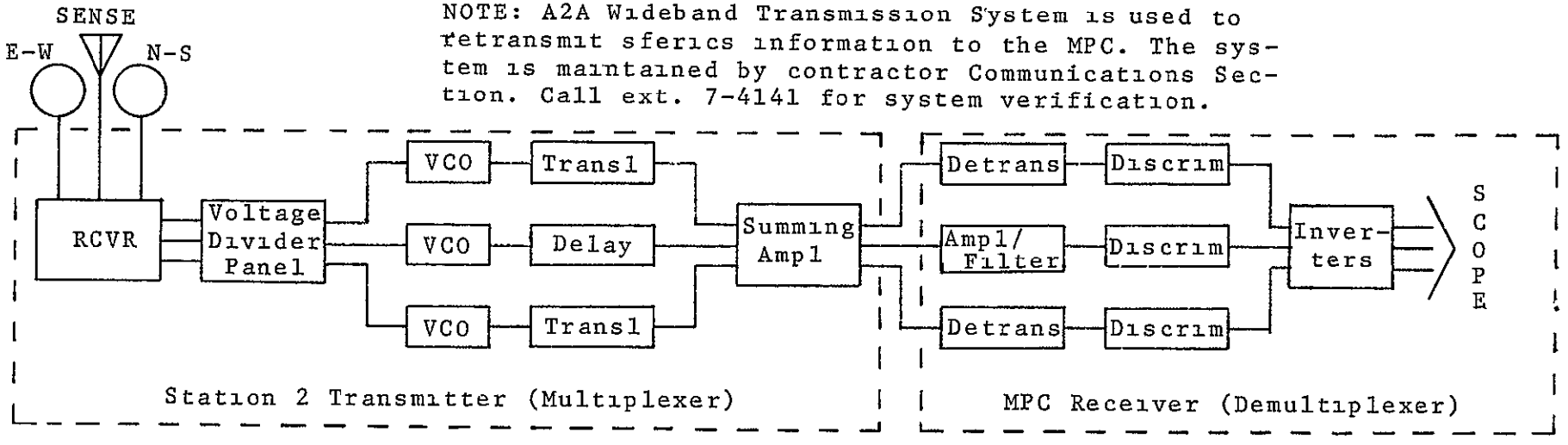

Figure 3-6. Sferics Station 2/MPC Lightning Configuration

Proceed as follows

FLD TECH	MPC OP
a. Verify the following control settings;	Standby for station transmitter setup.

FLD TECH	MPC OP
a. (Cont'd) 1. Power Supply, AC PWR switch is ON 2. VCO OUTPUT switches are ON 3. Sferics Receiver, POWER switch is ON, GAIN selector is at 40, WHIP AMPL switch is at NOR b. Connect DC Voltmeter to +16V and COM test points and, if necessary, adjust dc level to 16 ±0.5Vdc c. Repeat step b. for -16Vdc output of power supply. d. Connect frequency counter between white OUTPUT and black (ground) test jacks of Channel 1 VCO (extreme left module). e. Set SIG/CAL selector to ZERO. f. Adjust ZERO control for 900 ±0.9 kHz output on frequency counter. NOTE An optional setting for Channel 1 is 850 kHz as center frequency. This setting reduces second harmonic distortion caused by channel low pass filters. Further harmonic reduction may be achieved by using 800 kHz. The optional settings	Standby.

FLD TECH	MPC OP
NOTE (Cont'd) apply to setup of Channel 1 only. g. Set SIG/CAL selector to GAIN. h. Adjust GAIN controls for 540 ±0.9 kHz (490 ±0.9 or 440 ±0.9 kHz if option of above NOTE is exercised). i. Repeat steps e. through h. to compensate for interaction of ZERO and GAIN controls. j. Reset SIG/CAL selector to ZERO for remaining setup steps; then to ±2.5 for normal operation at completion of setup. k. Repeat steps d. through j. to apply to Channel 2 VCO. l. Repeat steps d. through j. to apply to Channel 3 VCO. m. Connect oscilloscope probe between OUTPUT test jack of TIME DELAY module and ground. n. Adjust Channel 1 VCO OUTPUT LEVEL for 0.16V peak-to-peak (p-p) output to oscilloscope. o. Connect oscilloscope probe between white CRYSTAL test jack and ground of Channel 2 TRANSLATOR (left module).	Standby.

FLD TECH	MPC OP
p. Adjust crystal amplitude to 0.8Vp-p. Signal level is adjusted by removing module from rack enough for access to gain control (via small hole in bottom of module), adjusting control, and returning module to rack to check results. Repeat this procedure until specified level is obtained. q. Connect oscilloscope probe between red INPUT test jack and ground. r. Adjust Channel 2 VCO OUTPUT LEVEL control for 0.05Vp-p response on oscilloscope. s. Connect oscilloscope probe between blue OUTPUT test jack and ground. t. Adjust translator GAIN control for 0 2Vp-p oscilloscope response. u. Repeat steps o. through t. for applicable controls and test points of Channel 3 VCO and translator modules - except that step t. response for Channel 3 is 0.16Vp-p. v. Connect oscilloscope probe between blue OUTPUT test jack and ground of SUMMING AMP. module. w. Determine summing action of module by switching each VCO OUTPUT off one-at-a-time. Output level of summing	Standby.

FLD TECH	MPC OP
w. (Cont'd) amplifier should decrease by one-third as each VCO is disabled. Return VCO switches to ON position.	Standby.
x. Adjust summing amplifier output GAIN control for a p-p reading of 1.45 times the desired Transmitter output voltage across a 124-ohm balanced load. The design normal setting is 1.45Vp-p at the test point to give a 0.22Vp-p output of multiplexed signal across a 124 ohm load. If GAIN control does not have sufficient range to get the desired voltage, the Channel 1 VCO OUTPUT LEVEL, Channel 2 Translator GAIN, and Channel 3 Translator GAIN may be increased or decreased from readings specified in steps n., t., and u. NOTE The Channel 2 and 3 VCO output levels may be decreased to reduce the Transmitter outputs still further, but should never be increased since excessive distortion may result.	

3.4.1.7 Sferics Station 2 Receiver (MPC Demultiplexer) Setup. The receiver units are located in Rack 4 at the MPC and the units are normally operating. To set proper levels of units involved, proceed as follows:

FLD TECH	MPC OP
Standby for receiver setup.	a. Verify that power supply AC PWR switch is in ON position. b. Perform steps b. and c. of paragraph 3.4.1.6. c. Connect oscilloscope probe between one red INPUT test jack and chassis ground of the input amplifier. d. Verify approximate 1.5Vp-p oscilloscope response. Check output of second red INPUT test jack for 1.5Vp-p response. (The voltage of the two test points should be the same.) NOTE The voltage from one red test point to the other measured differentially will be twice the voltage from one red test point to ground. The differential voltage is nominally 3.0Vp-p. Differential measurements must be used if the optional ground has been removed from the input transformer center tap. e. Connect oscilloscope probe between blue AMPLIFIER OUTPUT test jack and ground f. Adjust GAIN control for 6.0Vp-p on oscilloscope.

FLD TECH	MPC OP
If necessary, adjust Channel 1 output to specified value.	g. Connect oscilloscope between white FILTER OUTPUT test jack and ground and check for response of 0.05Vp-p. If response is not within 50% of specified value, request station setup verification by FLD TECH.
Standby.	h. Connect oscilloscope probe between white CRYSTAL test jack and ground of Channel 2 (left) detranslator unit.
	i. Check for crystal output of 0.8Vp-p. If necessary, remove module from rack enough for access to gain control in bottom of unit. Make nominal adjustment and return module to rack until level specified is obtained.
	j. Connect oscilloscope probe between red INPUT test jack and ground of module.
	k. Adjust GAIN control for 0.7Vp-p oscilloscope response.
	l. Connect oscilloscope probe between blue OUTPUT test jack and verify output signal of 900 kHz with amplitude of 0 20 to 0.27Vp-p.
	m. Repeat steps h. through l. to apply to Channel 3 (right) detranslator unit.
	n. Connect signal generator to white FILTER OUTPUT test jack of the input amplifier low pass filter unit and apply

FLD TECH	MPC OP
Standby.	n. (Cont'd) (oscilloscope verification) 900 kHz, 2.0Vp-p signal. If option (see para. 3.4.1.6 step f. NOTE) is Sferics Station 2 VCO output, set signal generator accordingly. NOTE The Channel 1 discriminator setup for a center frequency of 900 kHz will work satisfactorily with a Channel 1 VCO setting of either 900 kHz or 850 kHz center frequency If the discriminator and VCO are not set the same, there will be a dc component in the discriminator output which may be objectionable. o. Connect DC Voltmeter to red OUTPUT 1 test jack of inverters module and adjust ZERO control of Channel 1 (left) discriminator unit for 0.0 ±0.05Vdc reading. p. Connect signal generator to blue OUTPUT test jack of Channel 2 detranslator and apply 900 ±0.9 kHz, 2.0Vp-p signal (oscilloscope verification). q. Connect DC Voltmeter to red OUTPUT 2 test jack of inverters module and adjust ZERO control of Channel 2 discriminator

FLD TECH	MPC OP
Standby.	q. (Cont'd) for 0.0 ±0.05 Vdc meter reading. r Repeat steps p. and q. to apply to applicable units of Channel 3. NOTE Actions performed in steps n. through r serve to check both the discriminator and inverters modules.

3.4.1.8 Sferics Station 2 Input to MPC Output Verification. This procedure provides for final adjustment of MPC discriminator units to verify that analog level applied to sferics oscilloscope circuits are nominal outputs of the Sferics Station 2 SF-44 Receiver input to the station multiplexer system. This procedure requires actions on the part of station and MPC technicians after the preceding procedures have been completed. Proceed as follows:

FLD TECH	MPC OP
a. Establish voice contact between Station 2 and the MPC.	
b. Disconnect input cable to transition panel (P-1).	
c. Install jumper cables from positive signal of the generator to TEST POINT banana jacks X, y, and Z on back of transition panel. Install jumper	Connect oscilloscope probe and AC Voltmeter to red OUTPUT 1 test jack and chassis ground of Inverters module.

FLD TECH	MPC OP
c. (Cont'd) cables from the negative signal of the generator to signal banana jacks.	
d. Apply 20 kHz 1.0Vrms (1.414Vp-p) signal to transition panel jumper installed in previous step. Notify MPC OP that multiplexer units are operating for level checkout.	1. Verify 1.0Vrms output of Channel 1. If output is not as specified, adjust Channel 1 (left) discriminator until inverter output is 1.0Vrms. 2. Connect meter and oscilloscope probe to blue OUTPUT 1 test jack and verify -1.0Vrms reading.
e. Standby.	Repeat steps c. and d. to apply to OUTPUT 2 and 3 of inverters and discriminator units.
f. Standby.	Verify that Sferics Station 2 is operating and adjusted for nominal operation as per paragraphs 3.4.1.2 and 3.4.1.3.
g. Standby.	Verify scope indication of straight line extending from approximately 225 degrees to approximately 45 degrees.
h. Standby.	Increase Channel 1 discriminator LEVEL control until half of straight-line display disappears. (Trace remaining should appear as line from center of scope face to approximate 45-degree point.)
i. Remove jumpers, meters, oscilloscopes, etc., returning appropriate stations to normal operating conditions.	

FLD TECH	MPC OP
j. Verify control settings as follows: 1. DC Power Supply - AC PWR switch to ON 2. Voltage Control Oscillators - Power switches to ON, SIG/CAL switches to ±2.5 3 Receiver - POWER switch to ON, WHIP AMPL switch to NOR, GAIN selector to 40 db	Verify demultiplexer power supply AC PWR switch is set to ON
k. Perform visual check of all antennas, cables, and connectors.	Note in logbook that scheduled maintenance has been performed.

3 4.2 Sferics Plotting Operation. After checkout procedures (above), proceed as follows

Procedure	Action/Indication/Function
a. Verify the following control settings, Sferics Receiver - POWER to ON, WHIP AMPL to NOR, GAIN to position that allows operator to note strokes but does not peg PEAK FIELD STRENGTH meter (nominal 40 to 60).	1. Sferics plot setup.

Procedure	Action/Indication/Function
a. (Cont'd)	
Oscilloscopes - POWER to ON, FOCUS and INTENSITY for best trace display, PERSISTENCE to mid range (optional), Writing function switch to WRITE, WRITING RATE to NORMAL.	1. Sferics plot setup.
Differential Amplifiers - BANDWIDTH (KC) switches to 40, VERNIER to CAL and SENSITIVITY as required for best sferics display (both SENSITIVITY switches should be as same range for either scope), remaining switches should be as outlined in 3.4.1.3 b., c., and d.	1 Sferics plot setup.
b. Depress ARM REMOTE pushbutton	1. ARM REMOTE indicator lights
c. Depress AUTO LIFT pushbutton	1. AUTO LIFT indicator lights, and 2. Unit has been placed in dual (local or remote) control
d Depress DOWN pushbutton	1. DOWN indicator lights, but 2 Pen does not go down (is disabled by AUTO LIFT function).

Procedure	Action/Indication/Function
e. Observe traces of both scopes for strongest indication of sferics and determine approximate coordinate of best sferic display on either scope	1. Cloud-to-cloud discharges will appear as scattering bursts emanating from center of scope face, 2. Cloud-to-ground (and reverse) strikes will appear as strong, single traces from center to perimeter of scope face.
f. Simultaneously place both scopes in ERASE mode and allow switches to return to WRITE. Repeat step e and, when clear sferics activity is noted, immediately proceed to step h	1 Traces should erase and, when switches are released, 2 New sferics activity should be seen.
h Simultaneously switch both scopes to VIEW	1. Traces will be displayed on scopes.
i. Determine coordinates of both scope traces and dial them onto appropriates resolver verniers	1 LIMIT indicator will light or remain out (depending on distance of sferics activity from KSC) and, 2. If LIMIT indicator is not lit, proceed to next step.
j. Depress resolver unit PEN pushbutton	1 Arm of plotter board should travel to position on map of dialed coordinates, 2. Pen should drop automatically to plot the point, and, after release of the PEN pushbutton, 3 Arm returns to standby.
k. Circle plot made and annotate log (see para. 3.4.4)	

Procedure	Action/Indication/Function
l. Repeat steps f. through j. until a projected storm path is determined	1. Plotting of storm path NOTE If the storm path appears to be passing toward a critical (launch complex) area, notify Weather Bureau personnel assigned to announce critical conditions. Continue operation of the plotter board as outlined.
m. As storms approach PERSISTENCE control may be decreased and coordinates determined and set directly from observations of scope indications, thereby skipping the VIEW and ERASE functions	

3.4.3 Sferics Unscheduled Maintenance Procedure. Unscheduled maintenance is performed on the sferics system at times that the unit is known to be functioning improperly. If doubt exists as to validity of sferics information being received, perform checkout procedures of prior paragraphs. If such procedures show a malfunctioning unit, replace failing unit, and repair as per vendor instructions (see Allocation Document PC-LMS-1000 for listing).

3.4.4 Sferics Logbook and Map Annotation. A daily log (Operation Log - LWS, Attachment #1) is maintained by the operator of the MPC sferics system. The log is used to list lightning occurences observed and plotted on the display/plotting unit. Each strike is listed along with pertinent PG, CC, humidity, barometric pressure, and cloud ceiling information of nearby measurements sites. Maps are changed to provide individual tracking records for each storm plotted. A negative report (no strikes observed in area covered by map) for the day is filed also. Any maps used in plotting operation should be filed with the operations log, each map should be annotated with the date made, the numerical sequence, and operator initials.

APPROVAL

DESCRIPTION AND GENERAL
OPERATING GUIDELINE FOR
KSC LIGHTNING WARNING SYSTEM

Contractor Concurrence

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FEC 300

NASA

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